AUTO MECHANICS

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HENRY FORD TRADE SCHOOL

This is one of a series of lesson sheets prepared by instructors in Ford Schools for use in their classes.

Ford Apprentice School was organized in 1913 to train Ford employes in the metal trades.

Henry Ford Trade School was founded in 1916 to train mechanics and make it possible for a young boy to partially support himself while attending school. It is incorporated under Michigan law as a non-profit institution. The school occupies three acres of floor space and has class and shop equipment for 1800 students.

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HENRY FORD TRADE SCHOOL

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AUTOMECHANICS

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AUTOMECHANICS

AIMS

To present the basic principles of science as applied to the automobile and to provide an opportunity to visualize these principles by definite assignments.

To help the student learn something about the principles which underlie the successful operation of the automobile.

To familiarize the student with the essentials of automobile construction, maintenance, and repair.

TIME

Fourteen weeks, with a total time allotment of seventy hours--seven-week semesters with daily one-hour periods.

SUBJECT MATERIAL

- Textbooks
- Reference Books
- Cutaway Ford V-8 Engines and Parts
- Charts

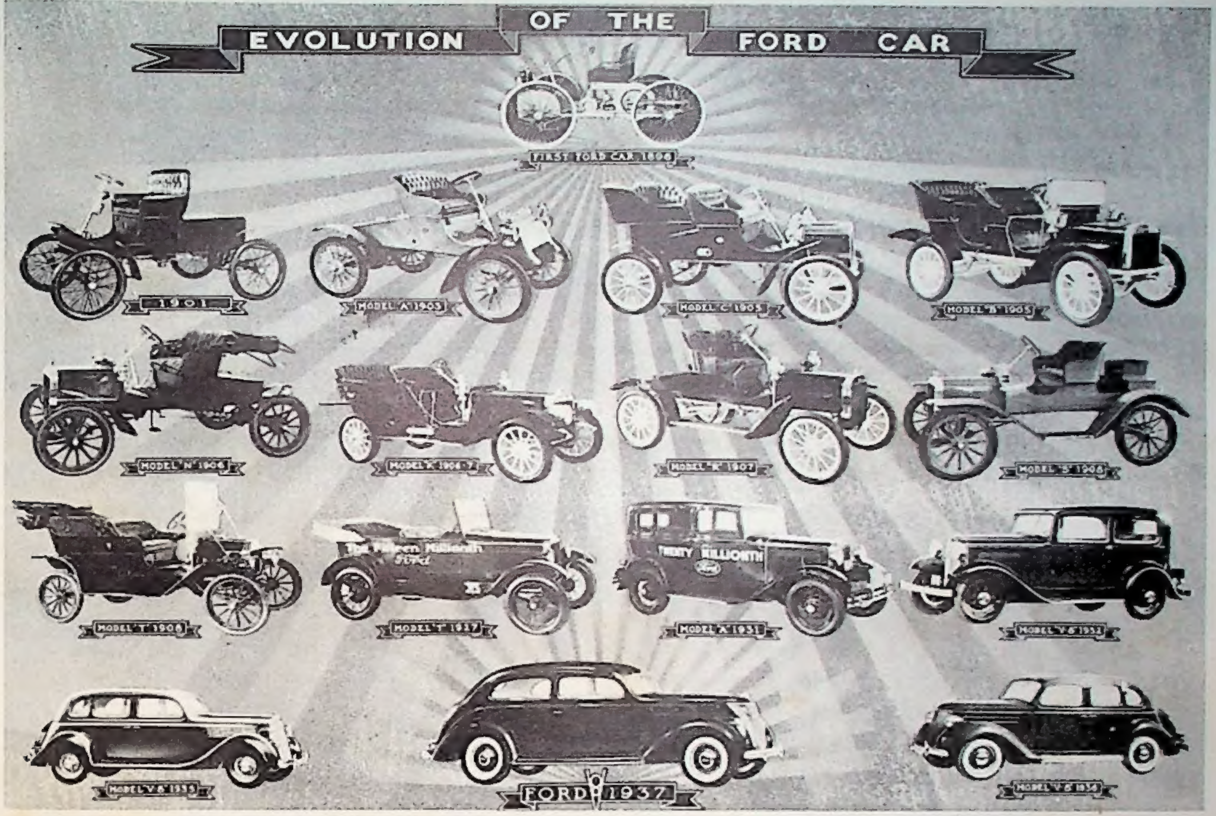
METHODS OF TEACHING

- Assignments
- Discussions
- Lectures
- Shop Tours
- Demonstrations
- Motion Pictures

SHOP TOURS

- Edison Museum
- Greenfield Village
- Motor Assembly
- Body Assembly
- Car Assembly
- Glass Plant
- Tire Plant

HISTORY



To trace the origin of the automobile one must go first to the steam carriage. The first one, built in France approximately one hundred seventy years ago, is in the Museum of Paris. It is a twin-cylinder, front-wheel-powered tricycle.

Steam carriages of all types were very popular until the first gasoline automobile made its bow to the public in Germany approximately fifty-five years ago. It was a single-cylinder, rear-wheel-powered tricycle.

American automobile history dates back approximately fifty years when the first modern American steam, electric, and gasoline cars were built. The first Ford car (see picture above) is a twin-cylinder, rear-wheel-powered gasoline car.

The American automobile industry really bagan approximately forty years ago. During the first few years more than two hundred makes of American cars appeared on the streets. During the 37 years that Ford Motor Company has been building cars more than 1300 other makes of American cars have been built. Besides Ford and Lincoln cars there are approximately twenty other makes of American cars built today.

The Ford Motor Company has built more than 28 million cars and trucks. More than $8\frac{1}{2}$ million of them are now in use on the highways of the United States. Ford cars and trucks in use today are approximately three-tenths of the total number of registered cars and trucks (all makes) in the United States. Total United States registration (all makes) is approximately seven-tenths of the total world's registration (all makes).

Total Ford production of cars and trucks is approximately four-tenths of the total American production (all makes). Total American production (all makes) is approximately seven-tenths of the total world's production (all makes).

ASSIGNMENT

List the chief improvements made each time the model was changed in the above picture.

LESSON 1 AUTOMECHANICS H F T

Group A No.________ Name ____________________

Corrected by No.________ Class ____________ Score __________
(No. Right

Answer the following. (Ten word limit for each.)

1. (a) In which country (France, Germany, or United States) was the electric car invented? (b) The steam car? (c) The gasoline car?

   (a) (b) (c)

2. How does the first gasoline car differ from the first steam car besides the kind of power and the power wheels?

3. How does the first Ford car differ from the first steam car besides the number o wheels and the kind of power?

4. How does the first Ford car differ from the first gasoline car besides the number of cylinders?

5. How does a modern Ford car differ from the first steam car besides the number of wheels and cylinders and the power wheels?

6. How does a modern Ford car differ from the first gasoline car besides the number of wheels?

7. How does a modern Ford car differ from the first Ford car besides the number of cylinders?

8. How many million cars (all makes) are registered in the world today? (Show work.)

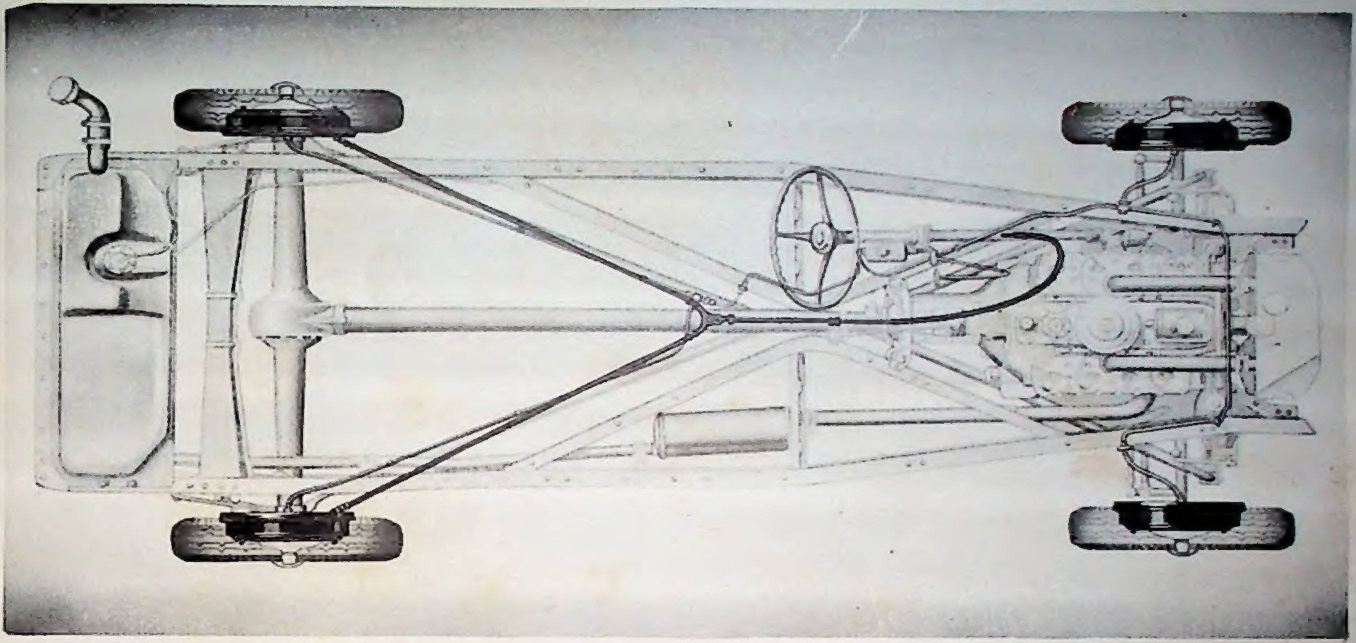
9. How many million American cars (all makes) have been built? (Show work.)

10. How many million American cars (all makes) have been built besides Ford cars? (Show work.)

Grade

A	B	C	D

CHASSIS



Ford V-8 Chassis

The two major parts of an automobile are called body and chassis (pronounced "sha-see"). The chassis is divided into the following four units:

1. Running Gear (tires, wheels, axles, springs, shock absorbers, torque tube, radius rods, frame, etc.).

2. Power Plant (engine, clutch, transmission, and fuel, cooling, lubricating, and ignition systems).

3. Controls (steering and braking systems, gear shift lever, switches, foot pedals, etc.).

4. Equipment (muffler, bumpers, starting and battery charging systems, etc.).

Chassis differ in many respects, especially in price, length, weight, and strength. They are also alike in many respects; for instance, they all have similar units and parts. All chassis are constructed on the same general principles, and, once these principles are understood, a student should have no difficulty in understanding the variations found in modern cars. For instance, the rear axle of modern cars is the power axle. Engines are water cooled and use gasoline for fuel. Transmissions permit the car to be driven backward and to climb hills. Clutches permit the shifting of the transmission gears. Steering is done with the front wheels. Brakes operate at each wheel. Electrical systems are for starting, lighting, horn, and supplying the engine with the firing spark.

ASSIGNMENT

Name 15 twin parts which are seen in the above picture. (Parts must be exactly alike and interchangeable.)

AUTOMECHANICS

LESSON 2

No. ________ Name ____________________

Group A

Class ____________ Score ____________ (No. Right)

Corrected by No. ________

Answer the following. (Ten word limit for each.)

1. Which major part of a car is more important, the body or the chassis? Why?

2. Which two chassis units are the least important? Why?

3. List two ways in which the Ford V-8 and the DeLuxe chassis are alike besides having similar parts.

4. List two differences between the DeLuxe and the Mercury chassis besides price, length, weight, and strength.

5. List two ways in which the DeLuxe and the Mercury rear axles are alike besides being the power axles and having similar parts.

6. List two ways in which the DeLuxe and the Mercury engines are alike besides being water cooled, using gasoline, and having similar parts.

7. List two ways in which the Ford V-8 and the DeLuxe clutches are alike besides being used when shifting the transmission gears and having similar parts.

8. List two ways in which the DeLuxe and the Mercury transmissions are alike besides permitting the cars to be driven backward and to climb hills, and having similar parts.

9. List two ways in which the Ford V-8 and the DeLuxe steering systems are alike besides controlling the front wheels and having similar parts.

10. List two ways in which the DeLuxe and the Mercury braking systems are alike besides operating at each wheel and having similar parts.

Grade

A	B	C	D

BODY

The all-steel, safety-glass-equipped, streamlined body has a reinforced, insulated, and soundproof roof which is welded to the reinforced and insulated side panels. The side panels in turn are welded to a one-piece floor.

The body types are: business coupe, convertible club coupe, coupe, fordor, and tudor.

Form-fitting, floating-edge seat cushions are cradled between the axles so that rear seat passengers sit nearer the center of the car. Hence, we speak of a "centerpoise" (mid-car) ride. The fore and aft, up and down, adjustable front seat, the sedan rear seat, and the recessed arm rests are upholstered with fabrics of exceptional quality. Broadcloth or mohair is the fabric used. Saddle-brown, genuine leather is used for the convertible club coupe seats.

The body equipment includes dual windshield wipers, left-side sun-visor, rear view mirror, cigar lighter, two instrument panel ash trays, speedometer, glove compartment and lock, water temperature and battery condition indicators, fuel and oil pressure gages, tools, and spare tire and wheel.

DeLuxe body equipment includes also a clock, right side sun-visor, robe cord, toggle grips, and rear seat ash trays.

Ford accessories include visor vanity mirror, side mirror, spot light, radio antenna (aerial), heater, defroster, seat covers for the body, gas tank locking cap, license-plate frames, bumper guards, oil filter, road (fog) lights, rear fender shields, governor, anti-freeze, cleaners and polishes, wheel bands, and repair kits for other places of the car.

Bodies have controlled ventilation--swivel type front door window ventilators, cowl ventilators, clear vision side windows that open at the top or at the front. Rear quarter side windows of DeLuxe fordor sedans are of the pivoted ventilating type.

Rust-proofing treatment of the sheet metal before the enamel is applied and baked prevents rust from creeping under the enamel when it is scratched, thereby causing it to crack and peel. Ford body enamel is unaffected by the ultra-violet rays of the sun which cause fading, or by anti-freeze solutions. Principal body colors are black, blue, green, gray, and maroon.

A lock-protected luggage compartment is provided under the rear deck of all bodies, where the tools and spare tire are kept. This permits the use of tools, etc., without disturbing the passengers and relieves them of the inconvenience of having luggage at their feet.

ASSIGNMENT

Draw a freehand sketch of each body type named in paragraph two above.

H F T S

AUTOMECHANICS

LESSON 3

No. ________ Name ______________________

Group A

Class ______________ Score __________
(No. Right)

Corrected by No. ________

Answer the following. (Ten word limit for each.)

1. Why is the Ford body called a "safety" body? Give two answers.

2. What are the two chief disadvantages of a tudor over a fordor?

3. What is the chief purpose of cradling the seats between the axles?

4. What kind of materials are used for upholstering the sedans?

5. Name four pieces of Ford V-8 body equipment that a car could do without.

6. Name four pieces of Ford V-8 body equipment that operate only when the engine is running.

7. Name the four least popular body accessories.

8. Where are the seven ventilating openings in a Ford V-8 fordor sedan body?

9. What are the two chief purposes of rust-proofing the sheet metal?

10. What are the two chief advantages of having the rear luggage compartment door on the outside?

Grade			
A	B	C	D

Ford Safety Glass

The chief ingredients that go into the making of a Ford Safety windshield are sand, scrap glass, soda ash, limestone, and salt cake. These materials are fed into the furnace in briquet form where they melt and fuse together at a temperature of 2700° Fahrenheit.

The glass is allowed to flow out of the furnace in a continuous stream between rollers which convert it into a ribbon about .250 of an inch thick, 50 inches wide, and of indefinite length. This ribbon runs through a long (425 feet) annealing oven.

The cooled annealed glass is inspected and cut into lengths (approximately eight feet) for handling. The cut sheets are set in plaster-of-Paris on iron tables and are passed under a long series of revolving cast-iron grinding discs and revolving polishing discs padded with cattle-hair felt until both sides are smooth. These discs produce a clear brilliant surface of polished plate glass about .125 of an inch thick. The grinding medium is sand and the polishing medium is rouge (ferric oxide).

After this flawless glass has been cut to the proper shape it is conveyed to the laminating room where it is washed chemically clean, dried, cooled, and inspected.

The vinal plastic used for the center of safety glass is .015 of an inch thick and must be carefully washed, dried, cooled, and inspected. It is cut to the proper size and assembled between two pieces of plate glass. The greatest care is taken to make sure that no dust or dirt gets into the so-called glass sandwich.

This sandwich continues down the conveyor and into a series of roller (tacking) presses and ovens where it is squeezed and heated so that it can be handled without separating. It is then loaded in trays and subjected to heat and pressure in the large autoclave presses that do the final binding and make the sandwich clear and transparent. The edges of the sandwich are then given a final grinding.

After edge-grinding, cleaning, and inspecting, the Ford insignia, reading "Ford Safety Glass," is clearly sandblasted into one corner of the glass. The month and year of manufacture are also indicated.

Ford Safety windshields are now ready for installation in Ford bodies.

ASSIGNMENT

Name 34 pieces of glass used in a DeLuxe Ford V-8 fordor. (Omit accessories.)

HFTS

AUTOMECHANICS

LESSON 4

Group A

Corrected by No.________

No.________ Name ____________________

Class ____________ Score ____________
(No. Right)

Answer the following. (Ten word limit for each.)

1. Name four ingredients used for glass that begin with the same letter.

2. How are the materials made into glass?

3. How does plate glass differ from the annealed glass emerging from the oven? Give four answers.

4. What is done to the plate glass immediately after it has been cut to the proper size and shape? Give four answers.

5. How thick is a piece of safety glass? (Show work.)

6. What is done to the plastic immediately before being used for safety glass? Give four answers.

7. What precaution is taken during the assembly of safety glass?

8. How is the plastic made clear and transparent?

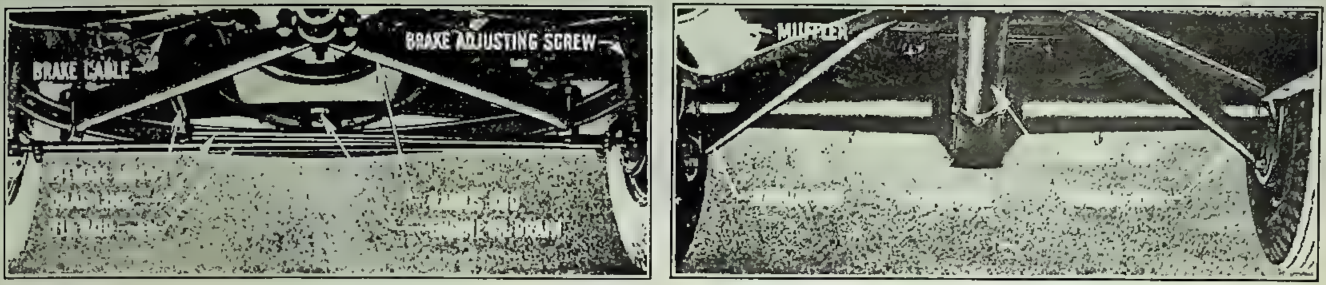
9. Is it possible to determine the age of Ford Safety Glass? Explain.

10. Give four advantages of plate glass over safety glass.

Grade

A	B	C	D

RUNNING GEAR



Front Rear

Ford V-8 Axles

The principal parts of the running gear are the tires, wheels, axles, springs, shock absorbers, torque tube, radius rods, and frame.

The steel wheel-bolting ring is attached directly to the brake drum. The distance between the centers of either the front or the rear wheels is called the tread, and the distance between the front and rear wheel centers is called the wheelbase. The tread in the rear is greater than the tread in the front.

The front axle is a dead type, not revolving with the wheels. The rear axle is a live, torque tube drive type; that is, the shafts revolve with the wheels.

By maintaining the axles in the correct lateral position, the radius rods prevent spring distortion, caused by road conditions or braking, and thereby insure maximum braking efficiency on all four wheels.

The torque tube prevents axle torque (twisting) when starting or braking and transmits the driving thrust of the rear wheels to the frame, freeing the rear spring of these strains and leaving it to perform its chief function of cushioning road shocks.

The hydraulic, double-acting, adjustable shock absorbers for all four wheels control spring action in both directions. They oppose the outward throw of the body and the lifting of the inside wheels when turning curves, thereby increasing stability and riding comfort.

The spring leaves are grooved lengthwise to permit pressure gun lubrication through the slotted center tie bolt. By placing the springs crosswise (transverse), unsprung weight and side-sway on curves are reduced and two springs are eliminated. The front spring is ahead of the front axle and the rear spring is behind the rear axle. This assures the riding ease of a longer car while retaining the handling and parking ease of a short one. The springbase is the distance between the front and rear spring centers.

The frame is of the X type with its four rigid cross members for added strength.

ASSIGNMENT

Draw a freehand sketch of the running gear, showing the eight parts (assembled) named in the first paragraph of this lesson.

H F T S

AUTOMECHANICS

LESSON 5

No. ________ Name ____________________

Group A

Class ____________ Score ____________ (No. Right)

Corrected by No. ________

Answer the following. (Ten word limit for each.)

1. Name four parts of a Ford car that make it ride smoothly.

2. (a) What is the distance between the two right wheel centers called? (b) The two front wheel centers?

   (a)

   (b)

3. Which wheels (front or rear) are farther apart? Why?

4. How does the front axle differ from the rear axle? Give two answers.

5. List two purposes of the radius rods.

6. List two purposes of the torque tube.

7. How would a car act if it had no shock absorbers? Give two answers.

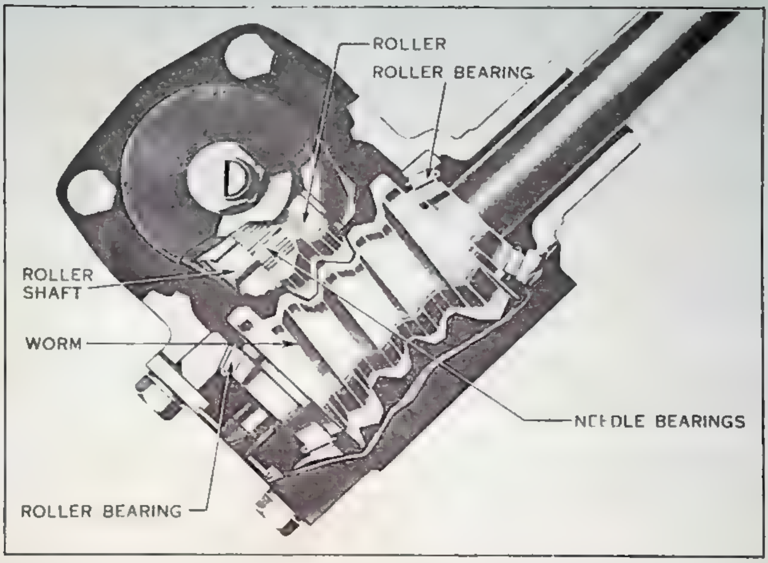
8. What are the two chief advantages of transverse springs?

9. What is the chief disadvantage of having the springbase shorter than the wheelbase?

10. Which part of the running gear is the least important and why?

Grade			
A	B	C	D

STEERING SYSTEM



Ford V-8 Steering Gear

The "finger tip" control steering gear is of the worm and roller type. The worm and roller (ratio 18.2 to 1) at the lower end of the steering shaft changes the rotary motion of the steering wheel to the lateral (side to side) motion of the pitman arm attached to the roller shaft. This arm then transmits the lateral motion to the right wheel spindle arm through the drag link, and then to the left wheel spindle arm through the tie rod directly behind the axle.

The front wheels, unlike the rear wheels, are neither vertical nor parallel, but are "cambered" (bowlegged) and "toed-in" (pigeon-toed). Camber means that the wheels are closer together at the bottom than at the top to place the front car weight on the large inner wheel bearings. Toe-in (not tread) means that the wheels are closer together at the front of the wheels than at the rear, to compensate for the toe-out caused by the camber.

In addition to camber and toe-in, the upper end of the spindle pins are tilted backward (castered), not unlike the front fork of a bicycle, to give the wheels a trailing action which automatically keeps them in a straight-ahead position, bringing them back into line after a hole, rut, or object has been struck or a turn has been made.

In addition to this backward tilt, the upper ends have a sidewise tilt toward the center of the car so that the center lines of the spindle pins intersect the center lines of the wheels at a point near where the tires contact the surface of the road, to decrease toe-out and make steering easier.

Not enough toe-in causes the inside edge of the tire tread grooves to wear sharp and too much toe-in causes the outside edge to wear sharp. The toe-in adjustment is accomplished by shortening or lengthening the tie rod. Incorrect camber or caster is corrected by straightening or replacing the spindles or axle, or both.

ASSIGNMENT

Name, in correct order, the ten chief moving parts of the steering system that are given in the first paragraph of this lesson. (Start with steering wheel.)

AUTOMECHANICS

LESSON 6

Group A

Corrected by No. ________

No. ________ Name ____________________

Class ____________ Score ____________
(No. Right)

Answer the following. (Ten word limit for each.)

1. What is the purpose of the worm and roller?

2. (a) How would a broken drag link affect the steering of the right wheel? (b) The left wheel?

   (a)

   (b)

3. Which wheel (right or left) would be affected more by a broken tie rod?

4. What is the purpose of the drag link?

5. What is the purpose of cambering the front wheels?

6. What does toe-in mean?

7. What is the purpose of tilting the upper ends of the spindle pins backward?

8. What is the purpose of tilting the upper ends of the spindle pins inward?

9. Number in the order of their importance the combinations that are the more essential for easy steering.

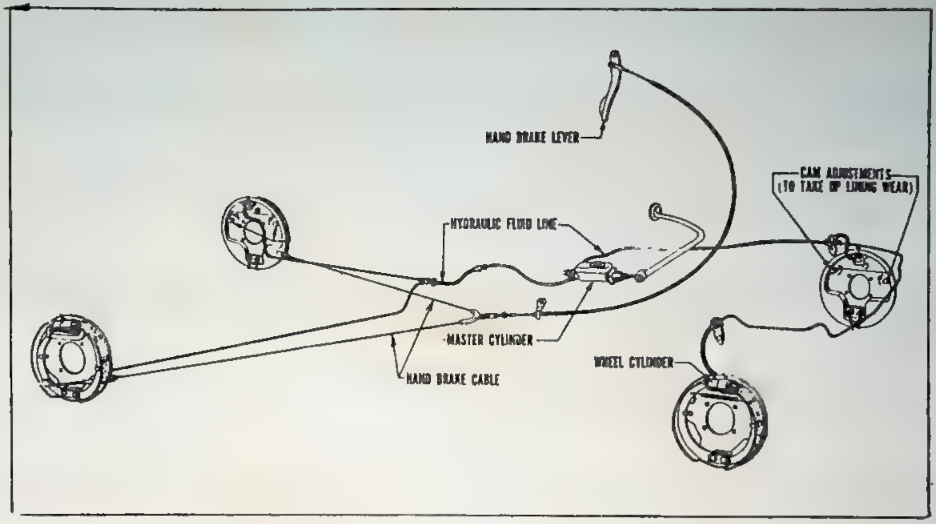
   ( ) Toe-in and camber
   ( ) Toe-in and caster

10. Underline the correct statements in the following:

    Lengthening the tie-rod decreases the toe-out.
    " " " " " " toe-in.
    " " " " increases " toe-out.
    " " " " " " toe-in.

Grade			
A	B	C	D

BRAKING SYSTEM



Ford V-8 Braking System

Safety of passengers, pedestrians, driver, and car depend to a great extent upon the proper operation of the braking system. Not only must it stop the car but it must do so quickly and smoothly. The ideal braking system is one that will decelerate (slow down) a car approximately 15 feet per second or 10 miles per hour per second under favorable weather, load, and road conditions. According to law all automobiles with four wheel brakes being driven upon any Detroit street must be able to stop within 30 feet traveling 20 miles per hour.

The braking system of the Ford is the hydraulic-mechanical, self-equalizing, super-safety type. The hydraulically operated stopping brakes consist of a foot pedal, master cylinder, fluid lines, fluid, wheel cylinders, shoes, linings, and four drums. The mechanically-operated parking brakes consist of a hand lever, steel cables, shoes, linings, and the rear drums.

The principle of operation of the stopping brakes is as follows: When the foot pedal is pushed downward the master cylinder piston forces fluid equally through the fluid lines to the four wheel-cylinders. The pressure of the fluid in each wheel-cylinder forces the two wheel-cylinder pistons outward. Linked to each wheel-cylinder piston is a lined brake shoe which moves outward until it sets up a strong braking resistance (friction) against the inside of the revolving drum. The cast alloy-iron, 12 inch drums are ribbed to minimize expansion and distortion when heated and for added strength and better cooling.

The principle of operation of the parking brakes is as follows: When the hand lever is pulled backward, the steel cables force the rear brake shoes to move outward against the drums.

Faulty brakes cause countless accidents. Brakes should be adjusted or relined when they will not skid the tires. The best method of testing the brakes is by an actual road test on dry pavement, with all the tires inflated to the correct pressure. Note: Brake drums must be cold when adjustments are made.

ASSIGNMENT

Draw a freehand sketch of the Lincoln vacuum power braking system and explain briefly its operation. (See Lincoln Reference Book, pages 39 and 40.)

H F T S

AUTOMECHANICS

LESSON 7

No.________ Name________________________

Group A

Class______________ Score __________
(No. Right)

Corrected by No.________

Answer the following. (Ten word limit for each.)

1. How important are good brakes?

2. How many seconds are required to stop a car traveling 50 miles per hour? (Show work.)

3. How many feet are required to stop a car traveling 50 miles per hour? (Show work.)

4. How do the stopping brakes differ from the parking brakes? Give four answers.

5. Name three parts of the stopping brakes that are parts of the parking brakes.

6. Which brakes will stop a Ford V-8 quicker, the hand-operated or the foot-operated?

7. Is it possible to stop a Ford V-8 quicker with both the stopping and parking brakes? Explain.

8. When are the brakes considered defective?

9. Where should the brakes be tested?

10. Is it possible to control (check) the speed of a car down a very steep hill without using either set of brakes? Explain.

Grade

A	B	C	D

AUTOMECHANICS

INSPECTION AND CHECK-UP

The mileage accumulated is usually considered the yardstick for judging the necessity for the various service operations and adjustments. However, all cars have additional requirements, such as inspections and check-ups, governed almost entirely by climatic conditions. A complete fall and spring inspection and check-up should be given to prepare a car for trouble-free driving during the approaching seasons. The procedure in a Ford V-8 inspection and check-up, for winter driving in Detroit, is as follows:

OPERATIONS

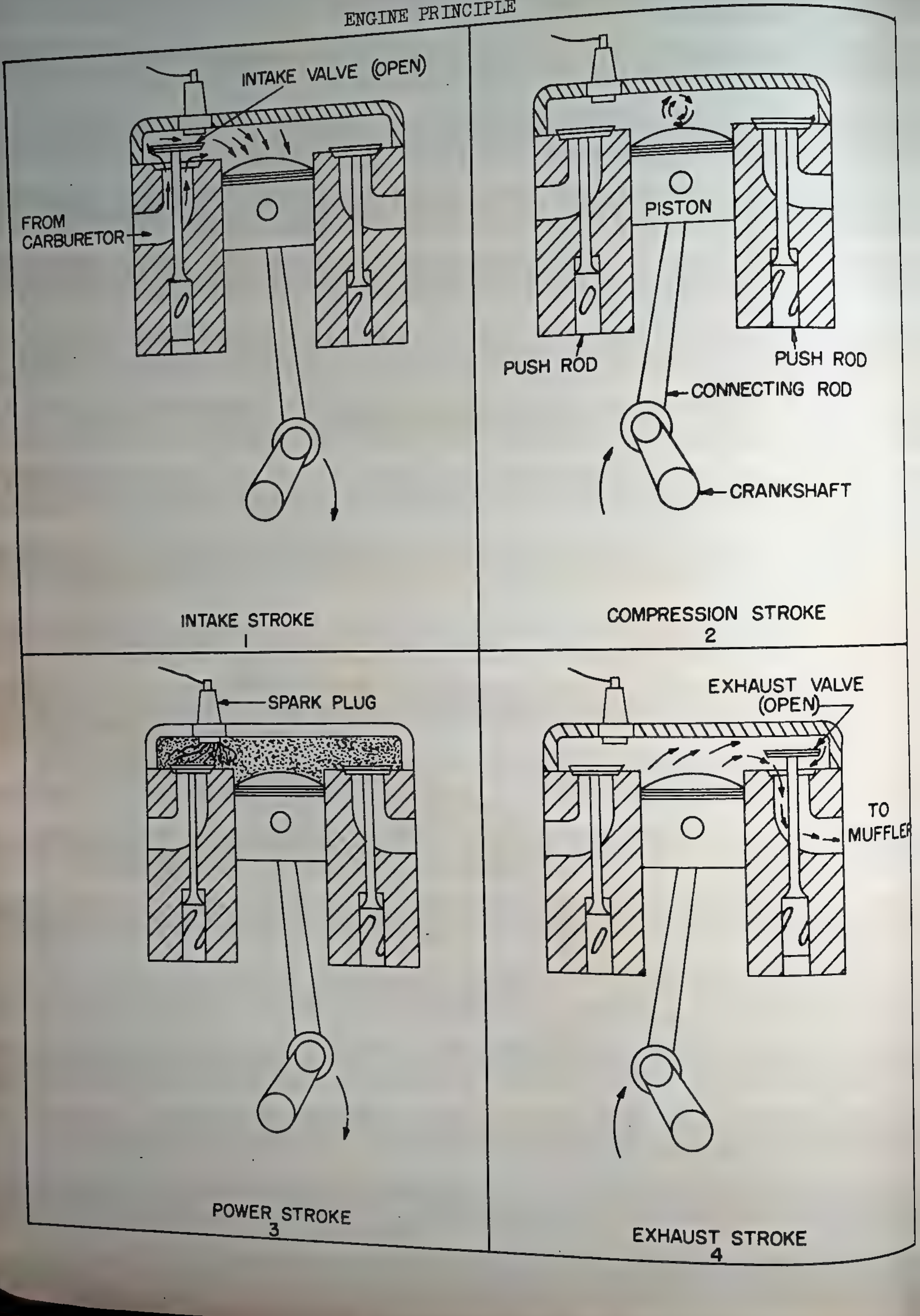
1. Drain engine (oil) pan and refill with oil (S A E #10 or #10W).*
2. Drain transmission and refill with gear oil (S A E #90).*
3. Drain rear axle housing and refill with gear oil (S A E #90 M E P).*
4. Lubricate chassis.
5. Inspect, fill with fluid, and adjust shock absorbers.
6. Check storage battery solution (level); add distilled water if low.
7. Clean, tighten, and grease battery terminals.
8. Clean ground connections on body and engine and tighten.
9. Tighten battery hold down clamp.
10. Inspect radiator, hoses, water pumps, and fan belt.
11. Drain, flush, and refill radiator with an anti-freeze solution.*
12. Clean and adjust spark plug gaps (.025").
13. Clean and oil carburetor air cleaner.
14. Clean and oil filler-assembly breather cap.
15. Clean fuel pump screen.
16. Drain fuel pump water trap.
17. Blow out gas line.
18. Drain carburetor float chamber (bowl).
19. Inspect windshield wiper and vacuum brake manifold connections.
20. Inspect lights for burned out bulbs and proper focus.
21. Check air pressure in the tires (30 pounds).
22. Start engine (crank at least one-half minute to prime fuel pump and carburetor).
23. Check spark at each plug ($\frac{1}{4}$" from wire to cylinder head).
24. Inspect windshield wipers, heater, blower, and defroster.*
25. Adjust carburetor idle screws (open approximately 3/4 of a turn) when engine is hot.
26. Adjust vacuum brake at distributor if engine pings when accelerating at low speed in high gear (screw in until the ping ceases).
27. Road test to check brakes.
28. Adjust brakes and road test.

* The operations in a Ford V-8 inspection and check-up for summer driving are the same as for winter driving, except for the following changes.

OPERATIONS

1. Drain engine (oil) pan and refill with oil (S A E #40).
2. Drain transmission and refill with gear oil (S A E #140).
3. Drain rear axle housing and refill with gear oil (S A E #140 M E P).
11. Drain anti-freeze, flush, and refill radiator with water.
24. Drain, disconnect, or shut off heater.
25. Adjust carburetor idle screws (open approximately 5/8 of a turn) when engine is hot.

ENGINE PRINCIPLE



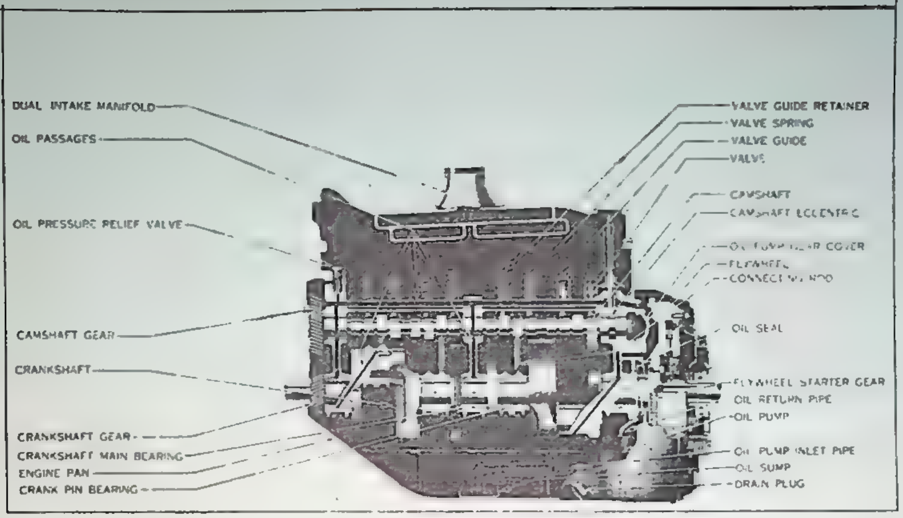
INTAKE STROKE 1

COMPRESSION STROKE 2

POWER STROKE 3

EXHAUST STROKE 4

ENGINE



Ford V-8 Engine

Ford V-8 engines, not unlike other automobile engines, are of the internal combustion, four stroke type; that is, the power is produced inside the cylinders, during one of the four strokes of each piston, by combustion (burning) of the fuel (gasoline).

The principal parts of the engine are the engine pan, cylinder block, cylinder heads, pistons, piston rings, piston pins, connecting rods, crank pin bearings, crankshaft, crankshaft main bearings, flywheel, crankshaft gear, camshaft gear, camshaft, valve push rods, valves, and valve springs.

Automobiles have engines of the Vee or straight (in line) type. The Vee type engine is shorter and more compact, is practically vibrationless, and requires less chassis space, thereby allowing more length for passengers within the body.

During the first downward stroke of the piston, called the intake stroke, the intake valve opens and the exhaust valve closes (see sketch sheet). As the piston moves downward in the cylinder, the cylinder pressure is reduced to about three pounds and the atmospheric pressure of approximately fifteen pounds forces air through the carburetor, mixing fuel with it, and then through the intake valve into the cylinder.

During the first upward stroke of the piston, called the compression stroke, the intake valve closes and the charge of fuel and air inside the cylinder is compressed (see sketch sheet). When the piston has completed the compression stroke, the charge of fuel and air is ignited by an electric spark at the spark plug points.

The high temperature developed during combustion causes the charge to expand with an explosive force, forcing the piston and connecting rod downward, and revolving the crankshaft and flywheel (see sketch sheet). This second downward stroke of the piston is called the power stroke. The flywheel absorbs most of this power and keeps the crankshaft revolving until the next power stroke occurs.

During the second upward stroke of the piston, called the exhaust stroke, the exhaust valve opens and allows the burned gases to escape through the exhaust muffler (see sketch sheet). When the piston has completed the exhaust stroke, the exhaust valve closes and the intake valve opens to begin a series (cycle) of four more strokes.

ASSIGNMENT

Explain briefly the difference of piston and valve action between the following strokes. (See sketch sheet.)

(a) Intake and Compression
(b) Intake and Power
(c) Intake and Exhaust
(d) Compression and Power
(e) Compression and Exhaust
(f) Power and Exhaust

H F T S

AUTOMECHANICS

LESSON 8

No. ________ Name ____________________

Group A

Class ____________ Score ____________
(No. Right)

Corrected by No. ________

Answer the following. (Ten word limit for each.)

1. Define a four stroke engine.

2. Give four advantages of a Vee type engine.

3. How does the engine become charged with the gas-air carburetor mixture?

4. During which piston stroke are both valves closed, the intake stroke or the exhaust stroke?

5. Which piston stroke occurs when the piston is going down, the compression stroke or the exhaust stroke?

6. After which piston stroke does the spark occur?

7. During which piston strokes are both valves open?

8. Name a principal non-moving engine part named in paragraph two and shown in the picture on the other side of this sheet.

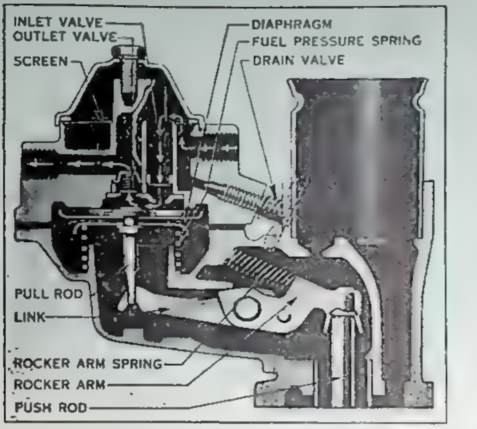
9. Name two principal moving non-rotating engine parts named on the sketch sheet.

10. Name four principal rotating engine parts named in paragraph two and shown in the picture on the other side of this sheet.

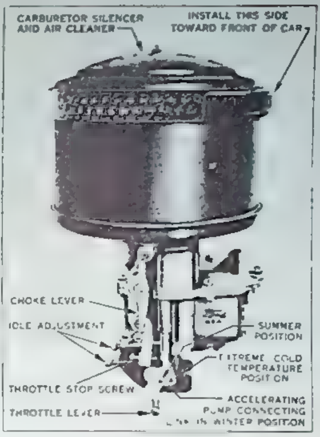
Grade

A	B	C	D

FUEL SYSTEM



Fuel Pump


CARBURETOR SILENCER AND AIR CLEANER
INSTALL THIS SIDE TOWARD FRONT OF CAR
CHOKE LEVER
IDLE ADJUSTMENT
SUMMER POSITION
EXTREME COLD TEMPERATURE POSITION
THROTTLE STOP SCREW
ACCELERATING PUMP CONNECTING LINK IN WINTER POSITION
THROTTLE LEVER

Carburetor

The Ford V-8 has a force feed type fuel system, the fuel being carried in a tank at the rear. From this tank the gasoline is drawn through the fuel line by the pump, which is driven by the engine camshaft, and forced to the carburetor. An electric fuel gauge on the instrument panel indicates the amount of gasoline in the tank.

Water and foreign particles must be separated from the gasoline and dust from the air before they reach the carburetor, or trouble may occur. The pump has a trap for removing the former and a screen for the latter. The dust in the air is removed by an air cleaner.

Liquid gasoline will not burn rapidly enough to produce much power, so a device called a carburetor mixes it with air to provide an explosive mixture for the engine. The principle of its operation is similar to that of a perfume atomizer.

The principal parts of the carburetor are the choke valve, operated by the hand button, which controls the quantity of air entering the carburetor when starting or warming up the engine; the spray jets or nozzles, which control the flow of gasoline mixing with the air; and the throttle valve, operated by the foot accelerator or hand button, which controls the quantity of gasoline-air mixture entering the engine, and therefore controls its speed.

The operation of the carburetor is explained as follows: Air enters at the top through the choke valve and places suction on the jets, depending on the amount of throttle valve opening. The gasoline-air mixture passes out the bottom through the throttle valve.

The Ford V-8 has a dual carburetor and intake manifold. Each barrel and jet of the carburetor supplies a gasoline-air mixture to four of the eight cylinders, which gives the same results as two separate four-cylinder carburetors.

CAUTION: Never attempt to operate an automobile engine or make carburetor adjustments in a small, unventilated garage. Exhaust gas contains carbon monoxide (CO) gas, which is a deadly, insidious poison when inhaled. Its presence is unnoticed because it is odorless, colorless, and tasteless.

ASSIGNMENT

Draw a freehand sketch of the fuel system of a Ford V-8, showing all the parts named in the first paragraph of this lesson.

H F T S

AUTOMECHANICS

LESSON 9

No. ________ Name ____________________

Group A

Class ____________ Score ____________
(No. Right)

Corrected by No. ________

Answer the following. (Ten word limit for each.)

1. Name the three principal moving parts of the fuel system.

2. How are water and dirt removed from the gasoline before it enters the carburetor?

3. Mark each of the following combinations as desirable (D), or undesirable (U), for the running of an engine.

   ( ) Water in the gasoline ( ) Gasoline in the air ( ) Dirt in the water

4. Mark each of the following principal parts of the carburetor as controllable (C), or uncontrollable (U), by the driver.

   ( ) Throttle valve ( ) Nozzles

5. How would pulling out the choke button affect a running engine?

6. How would opening the throttle valve affect a running engine?

7. Mark each of the following devices as alike (A), or unlike (U), that operate on the same principle as the carburetor.

   ( ) Blow torch ( ) Gas stove burner ( ) Water hose sprinkler

8. How would a clogged carburetor barrel affect a running engine?

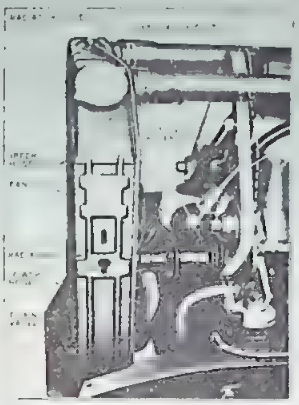
9. Why is it dangerous to run an automobile engine in a closed garage?

10. How does carbon monoxide differ from city gas? Give two answers.

Grade

A	B	C	D

COOLING SYSTEM



A method of cooling an automobile engine is necessary because of the intense heat of combustion, friction, and compression inside the cylinders, otherwise, the pistons would become tight and seize and the cylinders might become scored. (Caution: Never add cold water to the cooling system when it has become dry and the engine is overheated, otherwise, the cylinder heads or cylinder block may crack.)

The Ford V-8 has two pumps to help circulate the heated water from the jackets surrounding the cylinders and combustion chambers to the radiator to be cooled, and back again into the jackets to absorb more heat. An arrangement of fins around the radiator tubes carries off the heat of the water as it passes downward through the tubes. The heated fins are then cooled by the current of air passing between the fins and tubes. The fan helps the circulation of air through the radiator.

It is an erroneous idea that the cooling system is to keep the engine very cool, for it has been found that engines operate best when the water temperature is between 160 and 180° F. In the Ford V-8, thermostatic valves are provided in the cylinder heads to prevent the circulation of the water through the radiator until the engine temperature has been raised to the point where maximum performance and economy are obtained.

In localities where the temperature drops below freezing (32° F), a suitable anti-freeze solution of proper strength should be used in the cooling system. 180 proof denatured alcohol and ethylene glycol are the most popular of several anti-freeze liquids. Since alcohol is more volatile (easily vaporized) than water, it is necessary to add more at regular intervals, for evaporation will eventually weaken the solution until it becomes unsafe. Ethylene glycol is non-evaporating and more expensive. To control rusting of the iron in the cooling system, most brands of these liquids, as marketed, contain an effective rust inhibitor.

The following table indicates the approximate amounts of ethylene glycol and water or denatured alcohol and water to mix for various freezing temperatures.

1 pint of ethylene glycol and 2 pints of water or 33-1/3% is safe to zero.
7 pints " " " " 9 " " " " 45% " " " 20° below zero.
2 " " alcohol " 3 " " " " 40% " " " zero.
1 pint " " " 1 pint " " " 50% " " " 20° below zero.

ASSIGNMENT

Name, in correct order, the 12 parts of the cooling system through which water circulates, starting with the radiator.

HFTS

AUTOMECHANICS

LESSON 10

No. ________ Name ____________________

Group A

Class ____________ Score ____________
(No. Right)

Corrected by No. ________

Answer the following. (Ten word limit for each.)

1. What are the three chief causes of heat in an automobile engine?

2. What is the chief cause of scored cylinders?

3. Why is it dangerous to add cold water to the cooling system when it is dry and the engine is overheated?

4. In what part of the cooling system is the water when it is heating?

5. When is the fan more essential, in winter or in summer? Why?

6. What is the chief function of the thermostats?

7. How would the engine be affected if the thermostats failed to close?

8. What is the chief advantage of using alcohol in the cooling system in winter instead of ethylene glycol? The chief disadvantage?

9. Name three parts of the engine most likely to crack when the water freezes.

10. How many more quarts of alcohol are necessary in the 85 H P Ford V-8 cooling system (capacity 22 quarts) than in the 60 H P cooling system (capacity 16 quarts) to protect it for zero weather? (Show work.)

Grade			
A	B	C	D

ENGINE LUBRICATION

When an automobile is driven along a level road, some of the power developed by combustion is used to overcome the friction of the gears, bearings, and sliding parts. The remainder of the power is used to overcome air resistance. At a speed of approximately 40 miles per hour, the resistance to motion of the car is about evenly divided between rolling resistance and air resistance.

Rub the palms of your hands together briskly for a few seconds and they soon become too hot for comfort. The heat you feel is a result of friction. The same kind of friction causes heat and wear in the moving parts of a car. Friction, as a rule, is highly undesirable, but is made to serve a useful purpose in the clutch, brakes, and at the point of contact between the tires and the road.

The Ford V-8 engine has a pressure type of oiling system. Pressure is obtained by a gear type pump located inside the engine pan and driven by the camshaft. This pump draws oil through a filtering screen and forces it directly to the camshaft bearings and all crankshaft bearings. Oil escaping from the revolving crank pin bearings forms a spray which lubricates other engine parts.

Air circulates through the engine pan, eliminating water vapor that forms sludge and ice, and tends to cool the oil, reducing dilution to a minimum.

Engine oil should be drained about every 2000 miles and the engine refilled with a good quality oil of the correct number. Poor oil of the wrong number will carbonize quickly and gum up engine parts, causing excessive wear.

Engine oils of the following numbers are generally used in Ford cars in Detroit during the following months:

Month	Number of Oil
December, January, and February	10
March, October, and November	20
April, May, and September	30
June, July, and August	40

In the summer, engines over two years old should have the next higher number oil, to minimize oil consumption.

Engine oil becomes thinner (lighter) when heated and thicker (heavier) when cooled. The number recommended by the manufacturer should always be used.

ASSIGNMENT

Name all the parts of a car that require regular lubrication (omit engine).

H F T S

AUTOMECHANICS

LESSON 11

Group A

Corrected by No. ________

No. ________ Name ____________________

Class ____________ Score ____________
(No. Right)

Answer the following. (Ten word limit for each.)

1. How much power is lost overcoming friction of the moving parts of a car traveling 40 miles per hour?

2. Mark each of the following parts where friction is desirable (D) or undesirable (U).

   ( ) Bearings
   ( ) Tires
   ( ) Clutch
   ( ) Fan belt
   ( ) Gears
   ( ) Brakes

3. How can engine friction be increased? Give four answers.

4. Which method of lubrication is used for the following engine parts? Mark each part as pump (P) or spray (S).

   ( ) Pistons
   ( ) Camshaft
   ( ) Cylinders
   ( ) Piston rings

5. How would an engine be affected if air failed to circulate through it? Give four answers.

6. What are the three chief disadvantages of using poor oil?

7. Number in order the following oils that cause the most damage to an engine.

   ( ) Correct number of poor oil
   ( ) Wrong number of good oil
   ( ) Poor oil of the wrong number
   ( ) Good oil of the correct number

8. Which numbers of oil (10, 20, 30, or 40) are recommended for Ford cars in Detroit in the fall and in the winter?

9. What is the chief objection to using winter oil in summer?

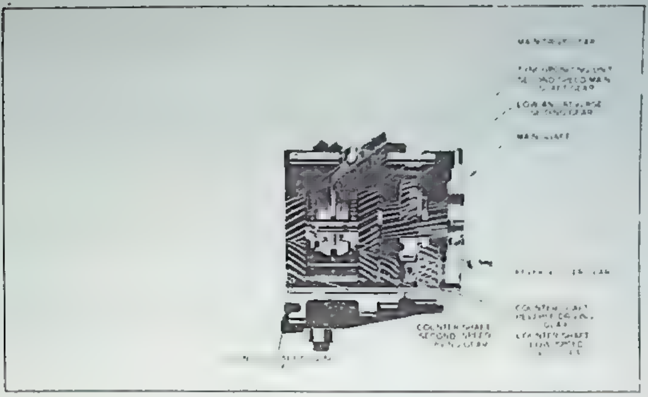
10. Number the following grades of oil as 10, 20, 30, or 40.

    ( ) Medium light
    ( ) Heavy

Grade

A	B	C	D

TRANSMISSION



Ford V-8 Transmission

If the flywheel of an automobile engine were connected directly to the rear axle, it would be almost impossible to park the car or drive it in traffic. A bicycle used for climbing hills must have a small driving sprocket-wheel for power, and if used for speed on level ground it must have a large driving sprocket-wheel. An automobile must meet varying road conditions. To overcome them, and for starting, reversing, and power, it is equipped with a gear box called a transmission.

The power developed by an automobile engine varies with its speed, increasing as the engine speed is increased. The transmission, located between the engine and the rear axle, permits the engine speed to be increased for maximum power at low car speeds. The Ford V-8 has a synchronized gear type of transmission. All eight gears have helical cut teeth for quietness in all speeds, including reverse.

The main drive gear receives engine power from the clutch. This gear is in constant mesh with the counter shaft driving gear which revolves the other three driving gears fixed to it and the reverse idler gear. Above the counter shaft driving gears is the main shaft. Fitted on it is the low and reverse sliding gear, the second speed main shaft gear, and the synchronizing unit.

Power is transmitted through the transmission as follows: For reverse gear, the low and reverse sliding gear (see picture) is meshed with the reverse idler gear in order that the main shaft will receive power from the main drive gear through the counter shaft driving gear, the counter shaft reverse driving gear, and the reverse idler gear.

For low gear, the low and reverse sliding gear is meshed with the counter shaft low speed driving gear in order that the main shaft will receive power from the main drive gear through the counter shaft driving gear and the counter shaft low speed driving gear.

For second gear, the synchronizing unit, which permits noiseless shifting, is meshed with the second speed main shaft gear in order that the main shaft will receive power from the main drive gear through the counter shaft driving gear, the counter shaft second speed driving gear, and the second speed main shaft gear.

For high gear, the synchronizing unit is meshed with the main drive gear direct in order that the main shaft will receive power.

ASSIGNMENT

(a) Name the three gears not in use when the transmission is in reverse gear.
(b) The four gears not in use in low gear.
(c) The four gears not in use in second gear.
(d) The seven gears not in use in high gear.

AUTOMECHANICS

H F T S

LESSON 12

No. ________ Name ____________________

Group A

Class ____________ Score ________
(No. Right)

Corrected by No. ______

Answer the following. (Ten word limit for each.)

1. What are the four chief purposes of the transmission?

2. When does an automobile engine develop maximum horse power?

3. Why is the transmission located between the engine and the rear axle?

4. What transmission gear rotates the other gears?

5. Is it possible for the low and reverse sliding gear to remain motionless when the counter shaft low speed driving gear is rotating? Explain.

6. Is it possible for the synchronizing unit to remain motionless when the main drive gear is rotating? Explain.

7. Is it possible for the second speed main shaft gear to remain motionless when the main drive gear is rotating? Explain.

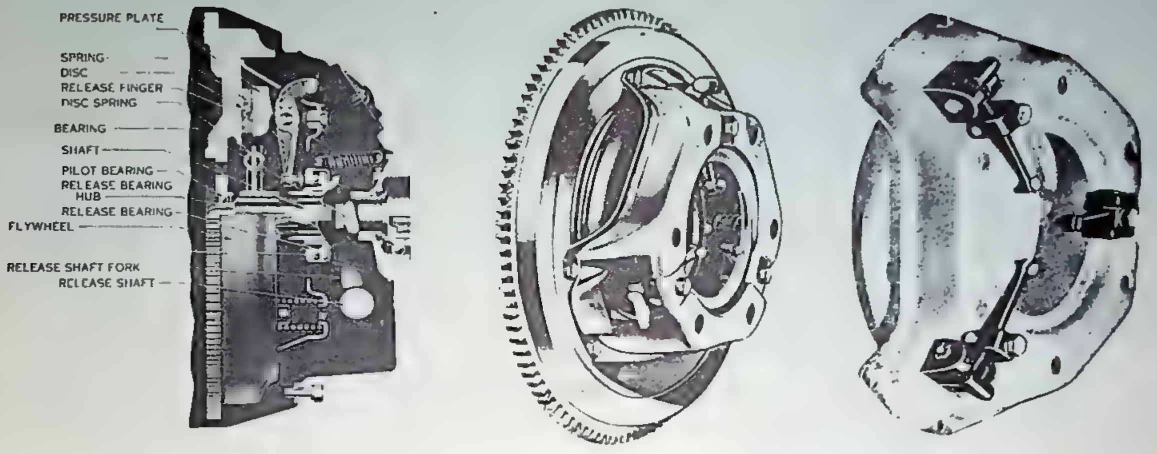
8. In which gear shift position are the least gears in use?

9. Name two gears that are used for both low and reverse besides the low and reverse sliding gear.

10. In which gear shift position has the car the most speed? Explain.

Grade			
A	B	C	D

CLUTCH



Ford V-8 Clutch

If the flywheel of an automobile engine were directly connected to the transmission, it would be almost impossible to shift the transmission gears. To enable the car to be started smoothly, it is provided with a friction clutch, attached to the flywheel and operated by the left foot (clutch) pedal. It connects and disconnects the engine power and the transmission gearing.

The Ford V-8 has a dry, single disc type of clutch. The clutch assembly consists of the pressure plate, attached to and revolving with the flywheel; the disc between the pressure plate and the flywheel, attached to the shaft which revolves the main drive gear of the transmission; and the springs and centriforce weights that squeeze the disc between the pressure plate and the flywheel until they operate as one. To prevent slippage between the flywheel, pressure plate, and disc, the latter is faced with a lining.

When the pedal is pushed down, the pressure plate and flywheel separate until they do not touch the disc, thereby allowing the main drive gear to remain motionless while the engine is revolving, and permitting the shifting of the transmission gears. When the pedal is released (up), the springs and centriforce weights gradually squeeze the disc between the pressure plate and flywheel again, causing the main drive gear to revolve with the flywheel.

The principle of the clutch can easily be illustrated by holding three coins between the finger tips--two pennies separated by a nickel. Without squeezing, it is easy to revolve the nickel and not the pennies, but squeeze them tightly and it becomes difficult to revolve the nickel without the pennies.

ASSIGNMENT

Name all devices that have a clutch besides automobiles.

AUTOMECHANICS

LESSON 13

Group A

Corrected by No.______

No.______ Name______________________

Class______ Score______________________ (No. Right)

Answer the following. (Ten word limit for each.)

1. How would a car act without a clutch? Give two answers.

2. Why is the clutch located between the flywheel and the transmission? Give two answers.

3. Name the clutch part that forces the disc against the flywheel.

4. Which side (front or rear) of the disc receives more wear? Why?

5. Is it possible for the clutch disc to remain motionless when the car is coasting downhill with the engine not in motion? Explain.

6. Is it possible for the engine to remain motionless when the car is coasting downhill with the transmission in gear? Explain.

7. Is it possible for the clutch disc to remain motionless when the engine is idling with the transmission in gear and the car not in motion? Explain.

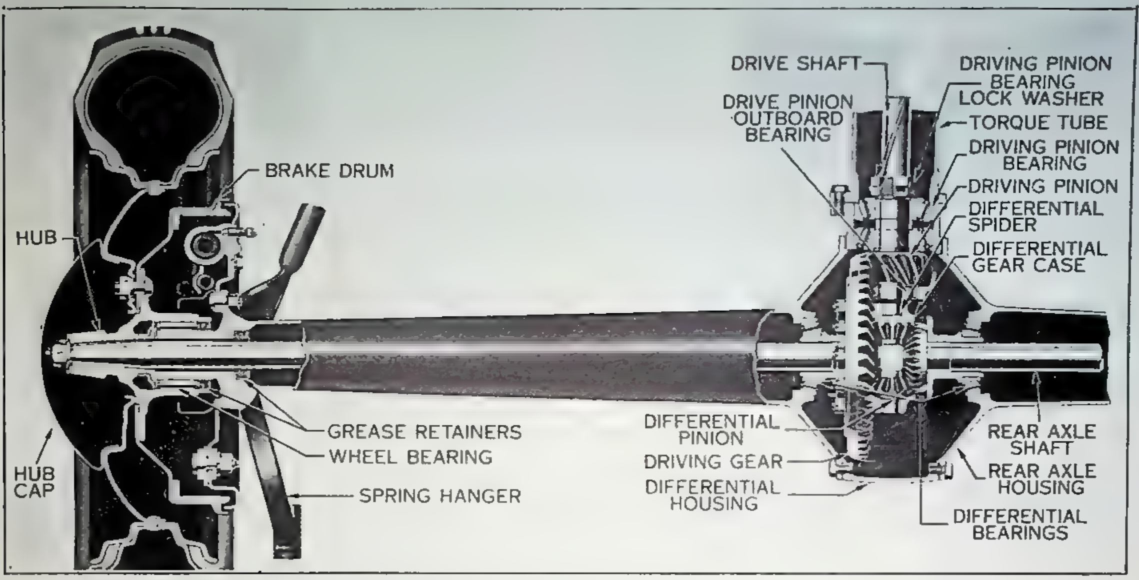
8. In which position of the clutch pedal (down, up, or between) does the clutch disc receive the most wear?

9. What clutch part does the nickel represent?

10. What clutch part or parts would a dime represent?

Grade			
A	B	C	D

REAR AXLE



Ford V-8 Rear Axle

The Ford V-8 rear axle is a three-quarter floating, torque tube drive type. In this type the rear axle housing supports the rear car weight, freeing the axle shafts of all weight strains and leaving them to perform their chief function of transmitting power to and holding the wheel hub and brake drum assemblies in the correct position.

Power is transmitted from the transmission to the rear axle by the universal joint and drive shaft, enclosed by the torque tube. The direction of the power is then changed at right angles to the drive shaft by means of two matched spiral beveled driving gears, a pinion attached to the rear end of the drive shaft and a ring gear attached to the differential gear case. The chief purpose of the differential is to divide the power unequally in order that both wheels may be driven and permitted to revolve at different speeds when turning curves. Turning curves at high speeds should always be done with the power on, and not off, for the outside wheel should lead and not drag. This tends to balance the car more and to prevent its upsetting.

Power is transmitted through the differential as follows: The ring gear revolves the differential gear case. This case revolves the differential spider shaft that carries the four differential gears (pinions). These pinions, which revolve with the spider and case, mesh between two differential gears facing each other on the inner ends of the axle shafts. Spider, pinions, and axle shaft gears revolve as one unit inside of and with the case. Each wheel ordinarily receives equal power, but in turning curves, the pinions inside the case revolve on the spider, besides revolving with the case. This double revolving pinion action divides the power unequally, permitting the two axle shaft gears to revolve at different speeds. The two rear wheel hubs, with roller bearings inside, are rigidly fastened to the outer ends of the axle shafts.

ASSIGNMENT

Name, in correct order, the ten most important revolving parts of the Ford V-8 rear axle, starting with the drive shaft (two or more of the same parts count as one).

LESSON 14

AUTOMECHANICS

H F T S

No. ________ Name ______________________

Group A

Class ____________ Score ______________________
(No. Right)

Corrected by No. ________

Answer the following. (Ten word limit for each.)

1. What are the two chief purposes of the rear axle housing?

2. Name the part that rotates the wheel.

3. What is the chief purpose of the drive shaft?

4. Name the two driving gears that change the power from a backward to a lateral (side to side) direction.

5. How would a car without a differential act when turning curves?

6. Why is coasting or braking when turning curves at high speeds more dangerous than turning with power on?

7. Which wheel receives more power when turning curves? Why?

8. Which wheel rotates slower when turning curves? Why?

9. Is it possible for one wheel to receive all the power? Explain.

10. Name the gears most likely to be worn when the rear axle makes noise only on curve

Grade

A	B	C	D

ELEMENTARY ELECTRICITY

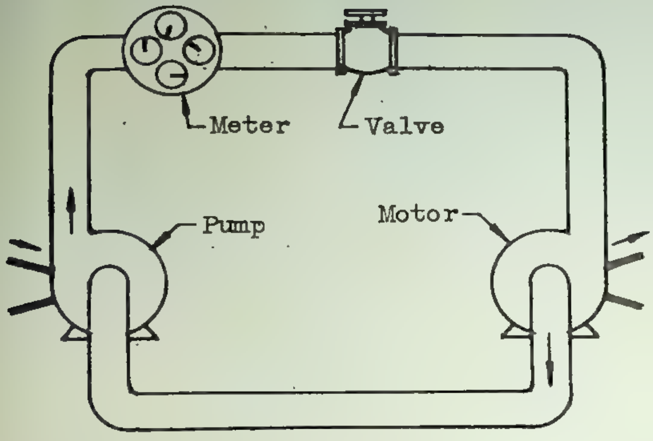


Fig. 1 Hydraulic Circuit

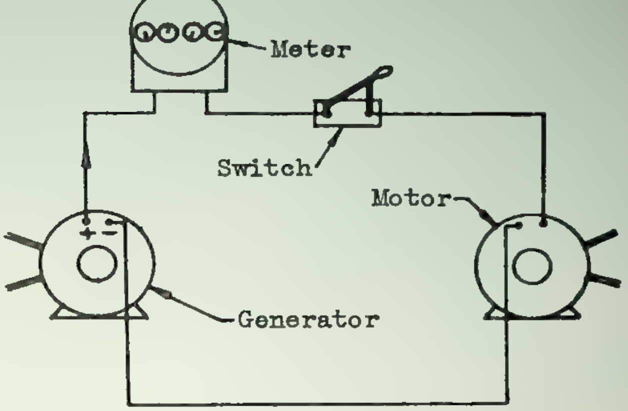


Fig. 2 Electric Circuit

In order to understand the principles and action of the electrical devices of a car, one should have some knowledge of electricity and magnetism. Electricity should not be confused with magnetism. They are closely related, but are two separate and distinct forms of energy. Therefore the purpose of this lesson is to enable the student to understand the action of current (flowing) electricity. To most people electricity is a dangerous, mysterious, and invisible power. It is neither a gas, a liquid, or a solid, but may be compared to water in its action.

Electricity is thought to be made up of countless billions of free-flowing electrons (the negatively charged portion of an atom) in a wire. Instead of moving in a haphazard direction, the electrons flow in only one direction. This electronic flow constitutes an electric current.

To understand how such a current may be established in a wire, we will consider the analogy of water flowing through a pipe. In the above picture (see Fig. 1), the water enters the pump at the intake at low pressure and discharges at high pressure. This difference in pressure causes a current of water to flow through the pipe, providing the valve is open. The quantity of water is measured by a meter.

A corresponding electric circuit is shown above (see Fig. 2). In the electric circuit a generator supplies the electrical force just as the water pump supplies the mechanical force. The positive and negative of the generator correspond to the discharge and intake of the pump. When the switch is closed (on), a current (amperes) will flow through the wiring, due to a difference in pressure (voltage) between the positive and negative of the generator. It is clearly seen that pressure is required to cause a current to flow in both pipe and wire. The quantity of electrical energy is measured by a meter.

There are two kinds of current electricity, direct and alternating. Direct current is a continuous current that flows in only one direction. Direct current of low voltage (6 to 8 volts) energizes the electrical system of the Ford V-8.

ASSIGNMENT

List 12 electrical devices on a Ford V-8 (omitting the lights and switches).

LESSON 15 AUTOMECHANICS H F T S

Group A

No.________ Name______________________

Corrected by No.________

Class________ Score______________________
(No. Right)

Answer the following. (Ten word limit for each.)

1. What are the two chief advantages of knowing something about electricity?

2. What is electricity?

3. How does electricity differ from water? Give four answers.

4. Which flows through the wiring, the amperes, or the voltage?

5. Which causes the current to flow through the wiring, the amperes, or the pressure?

6. How does a change in pressure affect the current?

7. How are electricity and water alike? Give four answers.

8. Which is current electricity, direct or alternating?

9. How does direct current differ from alternating current?

10. Which kind of current electricity is used in a Ford V-8 and why?

Grade			
A	B	C	D

MAGNETISM AND MAGNETS

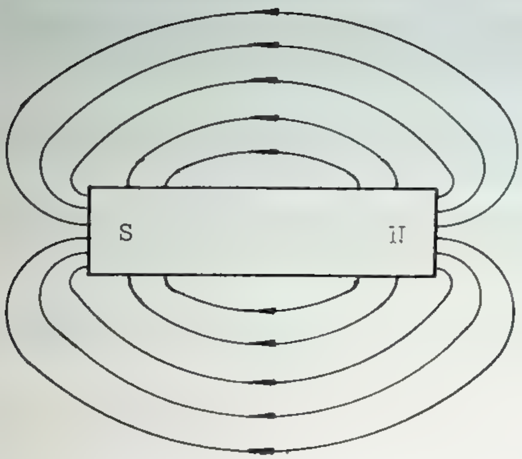


Fig. 1
Magnetism About a Permanent Magnet

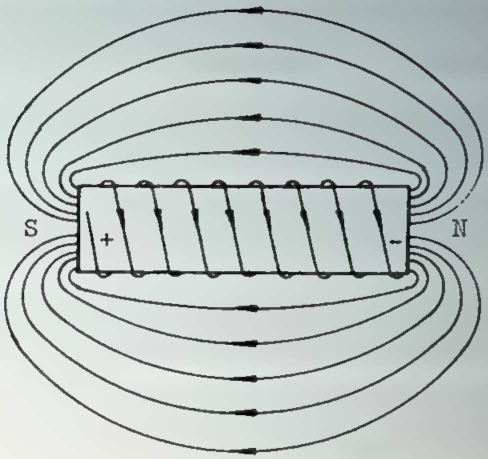


Fig. 2
Magnetism About an Electromagnet

As has been stated, one must have some knowledge of magnetism to understand the electrical system of a car. Therefore, the purpose of this lesson is to enable the student to understand magnetism and the action of magnets.

Magnetism, not unlike electricity, is a mysterious, invisible power and is neither a gas, a liquid, or a solid. It can be put into and retained in these few metals--iron, steel, cobalt, nickel, and some of their alloys.

All metals are composed of molecules that are thought to have a north and a south pole. In iron, steel, cobalt, and nickel these molecular magnets are comparatively strong, while in all other metals they are very weak. In an unmagnetized piece of metal they are arranged haphazardly and neutralize each other. In a magnetized piece of metal (a magnet) they line up with their north poles pointing in one direction, and their south poles pointing in the opposite direction. The magnetic power in a magnet is concentrated at the ends (poles), the center being very weak. The poles are designated as NORTH and SOUTH (and not as positive and negative or plus and minus).

The two kinds of magnets in common use are the permanent magnet made of magnetized hard steel, which will hold its magnetism indefinitely (see Fig. 1), and the electromagnet made of a core of soft iron with an insulated coil of wire wound around it (see Fig. 2). When an electric current flows through a wire, magnetism surrounds the wire, and when a current flows through the coil of an electromagnet, the core becomes magnetic. The strength of an electromagnet depends upon the amount of current flowing through the coil and the number of turns of wire around the core. The electromagnet becomes stronger when the current flowing in the coil is increased and weaker when the number of turns in the coil is decreased.

A law of magnetism is that like poles repel and unlike poles attract. Therefore, if the corresponding poles of two magnets are placed near enough together, the magnets will move away from each other. If the opposite poles are placed near enough, the magnets will draw toward each other.

ASSIGNMENT

List 6 pieces of Ford V-8 electrical equipment in which electromagnets are found.

AUTOMECHANICS

H F T S

LESSON 16

Group A

Corrected by No.________

No.________Name________________________

Class__________Score____________________
(No. Right)

Answer the following. (Ten word limit for each.)

1. How are electricity and magnetism alike? Give four answers.

2. How does magnetism differ from electricity? Give four answers.

3. How do the molecular magnets in unmagnetized iron differ from those in gold?

4. How do the molecular magnets in unmagnetized iron differ from those in magnetized iron?

5. Is it possible to change a permanent magnet into an electromagnet?

6. What causes the core of an electromagnet to become magnetic when an electric current flows through the coil?

7. In which direction does the magnetism travel inside the magnet?

8. Give two advantages of an electromagnet over a permanent magnet.

9. How can an electromagnet be made stronger? Give two answers.

10. (a) How do two magnets act when their south poles are placed near each other?
(b) A south and a north pole?

Grade

A	B	C	D

STORAGE BATTERY

Since the Ford V-8 is equipped with a starter, lights, etc., some means of providing electricity for them must be made. The storage battery, the heart of the electrical system, is a chemical device which produces low voltage (6 to 8 volts) direct current electricity for this purposes. Storage batteries, unlike dry batteries, are rechargeable.

Storage batteries have two kinds of plates, positive ones made of lead peroxide (PbO_2) and reddish-brown in color, and negative ones made of a spongy metallic lead (Pb) and gray in color. Grooved wood separators are not used to insulate the plates but are placed between them to prevent them touching (shorting), which is the chief cause of dead cells. The solution (electrolyte) in a storage battery is a mixture of sulfuric acid (H_2SO_4) and distilled water (H_2O). It conducts the current, between the plates, through the porous separators.

Most people have an erroneous idea that electricity is stored in a storage battery. When a storage battery is being charged, a chemical change is taking place in and between both the plates and the solution.

When a battery is discharging, the current flows out from the largest post, which is the positive. A white salt, lead sulphate ($PbSO_4$), forms on both positive and negative plates and the solution becomes weaker.

When a battery is being recharged, the direct current enters the positive post. The white salt that formed on the plates when the battery was discharging disappears into and strengthens the solution.

Distilled or water with a low mineral content should be added to the battery at regular intervals to offset evaporation and gassing.

Automobile storage batteries differ in many respects especially in quality and capacity. They are also alike in many respects, for instance they all have three cells and the same voltage. A Ford 120 ampere-hour battery has 51 plates (24 positive and 27 negatives). When charged, it is capable of producing enough electricity to either light the parking lights approximately 50 hours or the driving lights approximately 10 hours, to operate the radio approximately 20 hours, the horns approximately 5 hours, the starter approximately 20 minutes at 80° Fahrenheit, or the ignition system approximately 60 hours at approximately 40 miles per hour car speed.

CAUTION -- Keep batteries away from an open flame because battery gas is explosive. For acid burns on the skin or acid on the clothing, wash affected parts with a solution of baking soda. In winter, remove a discharged battery from the car, immediately, as it may freeze and crack the case.

ASSIGNMENT

How long would a (group A use, full, and group B use, half) charged Ford battery operate the radio after the parking lights had been on for five hours, the driving lights for one hour, the horns for one-half hour, the starter for one minute and the ignition system for six hours? (Use decimal fractions and show all your work.)

AUTOMECHANICS

H F T S

LESSON 17

No.________Name____________________

Group A

Class________Score____________________

(No. Right)

Corrected by No.________

Answer the following. (Ten word limit for each.)

1. What are the two chief reasons for using a storage battery in an automobile?

2. What material is used for the positive plates and what are their color?

3. What is the chief purpose of the wood separators?

4. Is it possible to store electricity in a battery? Explain.

5. What are the two chief purposes of the electrolyte?

6. When do the chemical changes take place between the plates and the solution?

7. When does a battery require more frequent inspections, in winter or in summer? Why?

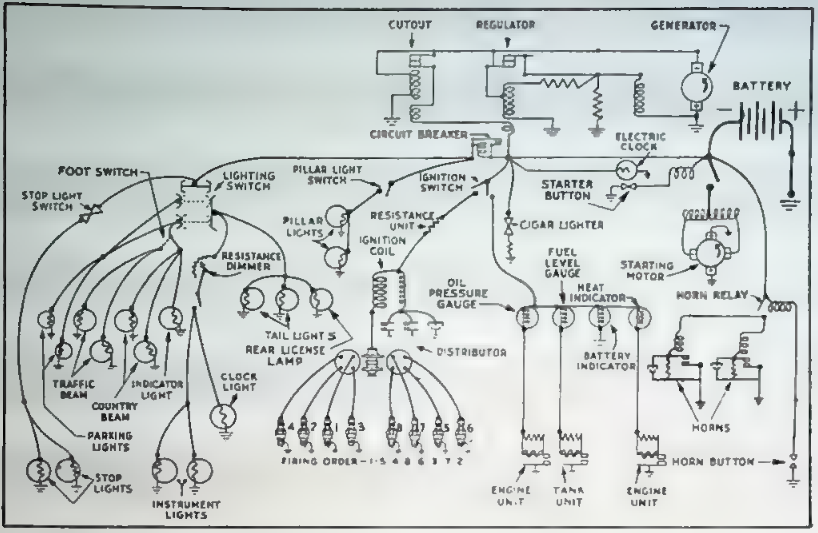
8. Give four ways in which automobile batteries differ from each other, besides quality, and capacity.

9. Name four moving pieces of Ford V-8 electrical equipment (not deluxe or accessories) that depend upon the battery for power (omitting the lights and switches).

10. Why is it dangerous to bring a battery near a flame?

Grade			
A	B	C	D

BATTERY CHARGING SYSTEM



Ford V-8 Electrical System

The electrical system of the Ford V-8 is divided into five main branches: Charging, starting, lighting, ignition, and miscellaneous.

As the storage battery supplies the electrical system with electricity when the engine is motionless, some means must be provided to keep it charged. The generator is a mechanical device, and when running, generates a low voltage (6 to 8 volts) direct current for this purpose.

The principal parts and the principle of operation of the generator is as follows. The chief parts are housing, field poles, field coils, brushes, and armature. When the armature revolves in the magnetic field, between the field poles, the magnetism generates a current in the armature coils. This is picked up from the armature commutator by the positive brush; thence, into the electrical system.

Ford V-8 cars have a two brush generator and a combination current regulator and cutout. The regulator automatically reduces the charging rate from 30 to 35 amperes to approximately six or seven when the battery becomes fully charged. Turning the lights on during the daytime, to prevent overcharging the battery, is unnecessary.

The cutout, an automatic switch is placed in the circuit between the generator and the battery to close the circuit when the generator is charging, otherwise the generator would burn out, and to open the circuit when the generator is stopped or not charging, to prevent the generator discharging the battery.

The battery indicator (gauge) is a voltmeter that indicates the electrical system voltage whenever the ignition switch is on. When the pointer remains in the left-hand red sector it indicates that the battery is low, when in the orange sector it indicates the generator output is being consumed by the electrical equipment and the battery is not receiving any charge, when in the green sector it indicates everything is normal, and when in the right-hand sector it indicates an unsafe voltage that may burn out the lights, radio, etc.

ASSIGNMENT

Draw a wiring diagram of the Ford V-8 battery charging system, showing the generator, regulator, cutout, battery, and battery indicator.

AUTOMECHANICS

H F T S

LESSON 18

No.________Name______________________

Group A

Class________ Score______________________
(No. Right)

Corrected by No.______

Answer the following. (Ten word limit for each.)

1. What part of the electrical system would be affected the most if the generator failed? How affected?

2. Which kind of current electricity does the generator generate?

3. When does the battery supply the electrical system with electricity? When does the generator?

4. Name four principal non-moving parts of the generator.

5. What is the chief purpose of the current regulator?

6. How would the battery be affected if the current regulator failed to operate?

7. How would a charging generator be affected if the cutout failed to close?

8. How would a battery be affected if the cutout failed to open when the generator stopped?

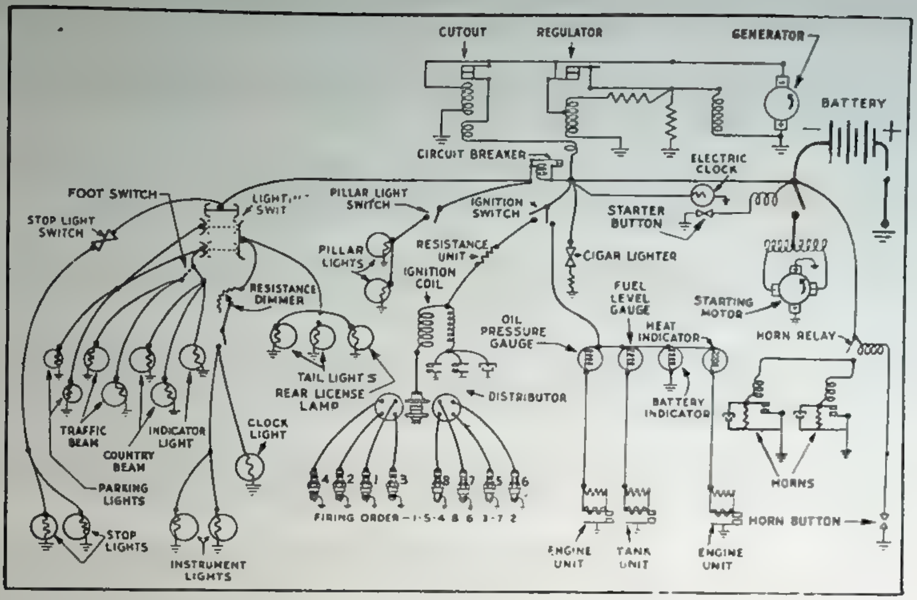
9. When the battery indicator pointer remains in the left-hand red sector what does it indicate?

10. When the battery indicator pointer remains in the orange sector what does it indicate?

Grade

A	B	C	D

STARTING SYSTEM



Ford V-8 Electrical System

In order that an automobile engine may run under its own power, it must first be cranked until one cylinder fires its compressed charge of gas. The starting system eliminates hand cranking, obtaining its power from the storage battery. When the starting system is in operation, the clutch pedal should be pushed down in order to disconnect the transmission from the engine. This permits the engine to rotate faster because the transmission gears remain motionless, resulting in quicker starting.

It would be impossible for the starter to crank the engine if it were directly connected to the engine crankshaft, not unlike the hand crank. Therefore, a gear reductio between the 10 tooth starter gear (pinion) and the 112 tooth flywheel (ring) gear, of 11.2 to 1 is necessary.

The Ford V-8 electrical system is of the single wire and ground type, that is, one terminal (post) of the battery is connected (grounded) to the frame of the car (see diagram) and the other terminal is connected to the wiring. The starting motor (starter) is wired with very large cables because of the enormous amount of current drawn from the battery.

The principal parts and the principle of operation of the starter are the same as those of the generator. When a current is permitted to flow through both the armature coils and field coils, a magnetic effect is produced between the armature core and field poles, which revolves the armature.

The operation of the starting system is as follows: when the starter button on the instrument panel is pressed, a circuit through the starter switch coil is completed and a magnet closes the contacts of the starter switch.

CAUTION: Never attempt to crank an automobile engine by hand except in an emergency. When necessary, be positively sure the thumb is placed on the same side of the crank as the fingers, for the engine may backfire (kick) and cause a serious arm injury.

ASSIGNMENT

Draw a wiring diagram of the Ford V-8 starting system, showing the battery, starter switch and coil, starter button, and starting motor (not ignition).

AUTOMECHANICS

H F T S

LESSON 19

No.________Name________________________

Group A

Class.________Score________________________

(No. Right)

Corrected by No.________

Answer the following. (Ten word limit for each).

1. Why is it necessary to rotate the crankshaft of an automobile engine before it will start running?

2. What are two other methods of starting an engine besides using the starter, cranking by hand, pushing, and towing the car?

3. When is it more advantageous to push down the clutch pedal when starting the engine, in summer or in winter? Why?

4. Which rotates faster when starting, the flywheel gear or the starter pinion? Why?

5. Which terminal (post) of a Ford V-8 battery is grounded, the positive or the negative, and of what advantage is this?

6. How does the size of the wiring of the starter differ from the other wiring? Why?

7. What causes the armature to rotate, the current in the coils or the magnetism?

8. How does a starter differ from a generator? Give two answers.

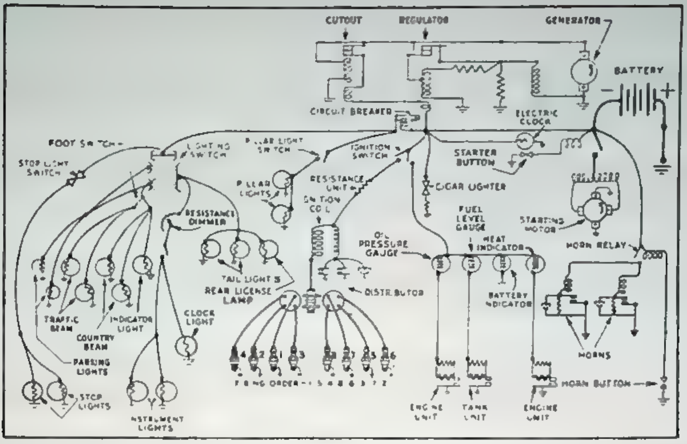
9. How are the starter and the generator alike? Give two answers.

10. When cranking an engine by hand, how should the crank be grasped and why?

Grade

A	B	C	D

LIGHTING SYSTEM



Ford V-8 Electrical System

According to law all automobiles driven upon any Detroit public highway at night (time between 30 minutes after sunset to 30 minutes before sunrise) must have its lights turned on. The required lights when driving are two front (head) lights, projecting white light, a rear (tail) light, exhibiting a red light to the rear and a rear (tail) light, illuminating the license plate with a white light.

Parking lights shall be lighted whenever an automobile is parked on a street, except when on a well lighted street like Gratiot, Woodward, Grand River, etc., and may be used instead of the headlights when driving on such streets.

Ford V-8 headlights are of the "Sealed Beam" type, in which the lens, reflector and bulb filaments are one sealed unit. The parking lights are mounted on the front fenders.

The lighting system is protected by a circuit breaker. In the event of a short circuit, this device limits the amount of current flowing to the bulbs, thereby dimming them.

There are two types of bulbs used in a Ford V-8, the single and the double filament (the threadlike wire inside a bulb). The single is used for all lights except the headlight and red tail and stop light.

There are two filaments in each headlight unit, one to provide a "country" or high beam for illuminating the highway when no other vehicles are approaching, the other filament gives a "traffic" or low beam for use in cities or whenever vehicles are approaching.

This "traffic" or low beam should always be used when meeting other cars to avoid the danger of dazzling (blinding) light shinning into the eyes of approaching drivers.

The double is used in the red tail light to provide a continous dim light and an intermittent brighter light when the brakes are applied.

The headlight reflectors direct the light rays forward and the lenses deflect the upward rays downward toward the road.

The candle power of the light bulbs are as follows:

Light	C.P.	Light	C.P.	Light	C.P.
Head		Stop	21	Beam indicator	1
Country beam	65	Tail (red)	3	Parking	1.5
Traffic beam	35	Pillar	3	Instrument	1
Clock	1	License	3		

ASSIGNMENT

Draw a wiring diagram of the Ford V-8 lighting system, showing the battery, circuit breaker, light switches, and all bulbs.

AUTOMECHANICS

H F T S

LESSON 20

No.________Name____________________

Group A

Class________Score____________________

(No. Right)

Corrected by No.________

Answer the following. (Ten word limit for each.)

1. When and why must a car in Detroit have its lights turned on?

2. Name the four most important lights on a Ford V-8 (pairs count for two).

3. Fill in the spaces below with the type (single or double), of each kind of bulb used in a Ford V-8.

Name	Type	Name	Type
Parking lights		License light	
Headlights		Stop light	

4. When should the high beam be used when driving?

5. Which headlight beam is brighter, the country or the traffic? Why?

6. What is the chief purpose of the headlight reflectors?

7. When are the stop lights the brightest, during the daytime or nighttime? Why?

8. Is it possible to use a parking light bulb for a license light bulb? Explain.

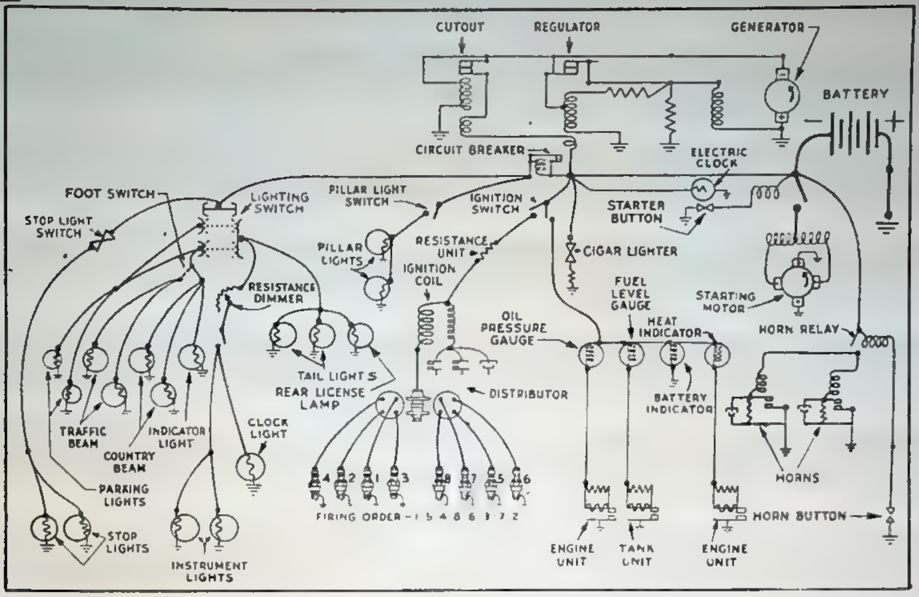
9. Is it possible to use a pillar light bulb for an instrument light bulb? Explain.

10. Is it possible to use a stop light bulb for a beam indicator light bulb? Explain.

Grade

A	B	C	D

IGNITION SYSTEM



Ford V-8 Electrical System

To produce power, the compressed charge of gas inside the cylinders of an automobile engine must be set afire. The ignition system, a mechanism for firing the charge, is both mechanical and electrical. It provides the spark for each cylinder at the proper instant. The source of current for it is provided by the battery when the engine is being started and by the generator when the engine is running.

The principal parts of the Ford V-8 ignition system are the battery or generator, the ignition switch, the resistance unit, the ignition coil, the condenser, the distributor, which includes the dual breaker points, the governor and vacuum brake, the rotor and caps, and the spark plugs.

The principle of operation of the ignition system is as follows: when the ignition (key) switch is "on" and the dual breaker points are closed a low voltage battery or generator current flows through the low voltage winding of the ignition coil and breaker points and charges the condenser. When the breaker points open the condenser discharges and the low voltage current induces a high voltage current (20,000 volts) in the high voltage winding of the ignition coil. The rotor and caps distribute the high voltage coil current to each spark plug in the proper firing order (1-5-4-8-6-3-7-2). The correct spacing of both the breaker points (.014 to .016 of an inch) and the spark plug points (.025 of an inch) is very essential for the easy starting and smooth running of the engine.

The distributor is connected to and driven by the camshaft. The governor and vacuum brake automatically controls the spark timing for various engine speeds and loads. The governor springs retard the spark to prevent backfiring (kicking) while the engine is being started, while the vacuum brake retards the spark to permit knockless acceleration under load. The governor weights gradually advance the spark as the engine speed is increased, to prevent overheating and permit more rapid acceleration and car speed.

CAUTION: Never permit the ignition switch to remain in the "on" position when the engine is motionless, for the battery may become discharged and some part of the ignition system damaged.

ASSIGNMENT

Draw a wiring diagram of the Ford V-8 ignition system, showing the battery or generator, switch, resistance unit, ignition coil, distributor, and spark plugs.

LESSON 21

AUTOMECHANICS

H F T S

Group A

Corrected by No.______

No.______ Name____________________

Class______ Score____________________
(No. Right)

Answer the following. (Ten word limit for each)

1. What is the chief purpose of the ignition system?

2. Which source of power is more important for the ignition system, the battery or the generator? Why?

3. Does the spark occur between any of the following combinations of strokes? [Mark each as yes (Y) or no (N).]
( ) Intake and Power
( ) Intake and Exhaust
( ) Intake and Compression
( ) Power and Exhaust
( ) Power and Intake
( ) Power and Compression

4. What is the chief purpose of the ignition coil?

5. Name four parts of the ignition system that are connected in the low voltage circuit.

6. How would the engine be affected if the governor springs failed to operate? If the vacuum brake failed?

7. How would the engine be affected if the governor weights failed to operate? (Give three answers.)

8. How would the ignition system be affected if the switch was not in the "off" position when the engine was not running? Give two answers.

9. What cylinders are connected to the right distributor cap? Give the numbers.

10. Which two cylinders that are connected to the left distributor cap fire in succession? Give the numbers.

Grade

A	B	C	D

TIRES

The chief materials that go into the making of a Ford tire are rust-resistant bead wire, cord fabric for the breaker strip and ply stock, square-woven fabric for the chafer stock and bead reinforcement, and rubber for treating the fabrics and tread stock.

The warm chewed-up crude rubber emerges from the plasticators and is mixed with carbon black, zinc oxide, and other chemical ingredients between the large rolls of a Banbury mill. All materials are automatically weighed to reduce the element of human error as much as possible.

The rolls of the Banbury mill are cooled to remove the heat generated by the friction of the rubber. After a batch is thoroughly milled (mixed) the rubber is cut into sheets, removed and hung on racks until needed for the next operation.

The rubber sheets are again warmed and reworked (mixed) in other mills and cut into a strip (One-half by eight inches) for the tread extruder where a steam-heated die gives the strip the tread shape. After cooling, the tread strip is automatically cut to the proper length for a tire.

The fabrics are rubberized between the calender rolls which apply a coating of rubber to both sides of the fabric. The fabrics are then bias-cut into the required widths and lengths.

Each bead consists of 20 turns (four five-strand loops) of rubber-coated, rust-resistant wire wound to the same diameter as the wheel rim (16 inches). One layer of bead fabric is wrapped around the wire for reinforcement.

The construction of a tire begins with the carcass (four layers of bias-cut cord fabric). The layers of ply stock are laid with the bias (angle) alternated for maximum strength. The plies are wound on the revolving collapsible cylinder of a tire-building machine; then beads, chafer stock, breaker strip, and tread strip are added.

The "green" tire from the tire-building machine is shaped with an inflated heavy duty inner tube (air-bag) in the tire bagging and shaping press. This gives the tire a finished shape before it is placed in a clam-shaped mold for molding, and curing. During the time (45 minutes) the tire is in the mold a steam pressure inflates the air-bag for six to eight minutes; then exhaust gas replaces the steam. The air-bag pressure forces the unmolded tread stock into the mold design, which forms the tread. The rubber is cured to give it the required elasticity (springiness).

The exhaust gas used in the air-bag, which is supplied by Ford V-8 engines, causes less deterioration of the air-bag, than compressed air.

The trade mark, the number, the size (6.00 × 16 inches), the number of plies (4), etc. are clearly molded into the side wall of the tire while it is in the mold.

After the finished tire is removed from the mold it is conveyed to the de-bagging machine which removes the hot air-bags automatically. The tire is cleaned, given a balance test, inspected, and filled with a partially inflated inner tube. It is now ready for installation on a wheel or for shipment.

ASSIGNMENT

Write an essay explaining the proper method of removing a tire from a rim, patching and testing the inner tube, and replacing the tire on the rim.

LESSON 22

AUTOMECHANICS

H F T S

No.________ Name________________________

Group A

Class__________ Score____________________
(No. Right)

Corrected by No.________

Answer the following. (Ten word limit for each).

1. Name the parts of a tire that are made of fabric.

2. How are the chemicals and rubber mixed?

3. What is the bead of a tire?

4. What are the plies of a tire?

5. What are the two purposes of the air-bag?

6. What happens to the "green" tire when it is in the mold? Give two answers.

7. What is the tread of a tire?

8. Give four ways in which automobile tires differ from each other, besides trade mark, number, size and number of plies.

9. What does the tire size (6.00) represent?

10. What are the four final operations after the tire has been debagged?

Grade

A	B	C	D

SAFTEY

With approximately 40 million drivers of cars, busses and trucks in the United States, many of which are driven by careless, unfit, or unskilled drivers, the need for better drivers is greater than ever before in order to reduce the number of traffic deaths and injuries.

The reckless, inexperienced, and unskilled driver risks his own life and endangers the lives of passengers, pedestrians, and other motorists every time he ventures on the road. A real driver does more than start, guide, and stop his car. He controls its every action. He is at all times alert to anticipate possible blunders of passengers, pedestrians, and other drivers.

The majority of fatal accidents are caused by young heedless drivers, and the minority by good drivers who momentarily become inattentive and fail to control their cars. Less than 10% of the fatal accidents are caused by mechanical defects in the automobile.

Learn the fine points of skillful driving. Experts are rarely involved in fatal accidents, because they know and obey most traffic ordinances and have their cars under control at all times. A study of local traffic ordinances is very essential, for ignorance coupled with recklessness, heedlessness, or carelessness is the most frequent cause of serious accidents. Approximately 90% of the fatal accidents are caused by speeds too fast for existing traffic conditions.

When approaching an intersection, the average driver requires approximately one-half second of time to look in each direction, and three-fourths of a second to remove his foot from the accelerator and apply the brakes (mind and foot reaction time.)

The approximate braking-distance for the average car while the four wheel stopping brakes are applied can be determined from the following formula:

(Miles per hour × miles per hour) ÷ 20 = Braking-distance in feet.

Note: Number 22 instead of 20 should be used in the formula for cars with excellent stopping brakes.

Example: Two average drivers, Approaching an average non-stop residential intersection at right angles and at the same time and speed (30 mph or 44 feet per second), are unable to see each other, due to buildings, etc., until both cars are approximately 71 feet from the collision point. During the mind and foot reaction time both cars move 33 feet, or within 38 feet of the collision point. It would be almost impossible to avoid an accident, since the braking-distance of a car with excellent brakes traveling at this speed is approximately 41 feet.

The following six chief suggestions for preventing fatal accidents, are listed in order.

1. Know and obey speed limits.
2. Drive carefully (not reckless) and be courteous.
3. Drive on the right half of the road.
4. Obey traffic signals, signs, rights-of-way, etc.
5. Know the chief traffic rules and drive accordingly.
6. Keep brakes, steering, lights, etc. in proper working order.

ASSIGNMENT

List the entry with the highest percentage in each of the sixteen tables in the book "Smash Hits".

AUTOMECHANICS

HFTS

LESSON 23

Group A

Corrected by No.________

No.______ Name____________________

Class________ Score____________
(No. Right)

Answer the following. (Ten word limit for each.)

1. Why are better drivers needed in the United States today? Give two answers.

2. What type of driver causes the most serious accidents, and what traffic ordinance is usually being violated?

3. How many more feet are required to stop the average car than one with excellent stopping brakes at a speed of 45 miles per hour? (Show work).

4. How many feet are required to stop the average car with the parking brakes at a speed of 45 miles per hour? (Show work.)

5. How many feet does a car travel when approaching an intersection during the time the driver looks in both directions when traveling 45 miles per hour? (Show work),

6. How many feet does the car in problem five travel while the driver removes his foot from the accelerator and places it on the brake pedal? (Show work.)

7. How many feet does the car in problem five travel while the driver jams on the brakes and stops it? (Show work.)

8. How many feet does the car in problem five travel, during the time the driver looks i both directions, removes his foot from the accelerator and places it on the brake and stops the car? (Show work.)

9. How many feet does the car in problem eight travel, if the driver has removed his foot from the accelerator and has placed it on the brake pedal before he looks in both directions? (Show work.)

10. How many feet does the car in problem nine travel if the driver needs to look in one direction only? (Show work.)

Grade

A	B	C	D

H F T S AUTOMECHANICS LESSON 24

Group A No.__________ Name______________________

Corrected by No.__________ Class____________ Score________________
(No. Right)

Detroit Traffic Ordinance

What section (heading) of the Detroit Traffic Ordinance is most likely to be broken by each of the following drivers. (No two answers are to be alike.)

1. Back seat.

2. Gangster.

3. Inexperienced.

4. Old (aged).

5. One who cannot read.

6. One who is deaf.

7. One with an old car.

8. Reckless.

9. Road hog.

10. Tourist.

Grade

A	B	C	D

Detroit Traffic Ordinance

The following is a list of traffic violations and their corresponding penalties.

Court cases -- Upon conviction a violator is subject to a maximum fine of $500.00 and imprisonment for 90 days.
Reckless driving - Defective brakes-causing accident - Drunk driving - Driving through occupied safety zone or car stop - Leaving the scene of an accident (hit and run) - Failure to report an accident.

Driving without a license (never had one) $10 - Cutting in and out of traffic $8 - Cutting in front of moving traffic at an intersection $8 - Failure to give right-of-way to on coming traffic at intersection making left turn. $8.

The following are $5 fines.
Driving against traffic, left side of street - Driving over fire hose - Failure to give right-of-way to fire trucks, police, and to pedestrians at intersections - Ignoring officer's signal (school crossing) - Left of street car - Pushing another vehicle into prohibited area - Straddling traffic lane markings - Through a funeral procession - Defective brakes or steering equipment - Allowing unlicensed driver to drive car - Student driver unaccompanied by licensed driver - Student driver accompanied by licensed driver and passengers- Driving a car with a bell, siren or whistle.

The following are $4 fines.
Failure to stop at stop street or stop intersection - Failure to stop at red railroad or other flashing light - Failure to stop leaving alley or driveway - Through an amber light - Through a red light - Turn against red or amber light.

The following are $3 fines.
Blockading traffic or street car - Two on a bicycle - Backing around a corner, no observer - Crossing in front of moving street car - Failure to signal on turn or leaving curb - Failure to slow down to a reasonable speed passing stopped street car at a safety zone - Failure to stop with street car - Four in driver's seat - Improper towing-cars or trailers - Lap driving - Passed stopped street car on left without stopping on one-way street - Interfering with traffic signs - Overloading- Impounded cars.

The following are $2 fines.
Blockading alley, crosswalk or driveway - Bicycles more than two abreast - Cyclists riding without two hands on handlebars - Arm around passenger or driver - Backing more than 60 feet - Failure to observe drive to right signs - Driving to right of traffic - less than four lane highway - Driving on sidewalk - Slow cars not keeping to right - Improper and prohibited turns - Wrong way, one way street - Defective muffler or bumpers - Improper noise-making equipment - No driver's license-expired, lost, or defaced - Improper or expired license plates - Excessive moise, muffler, horn or exhaust - Obscured vision - Riding on outside of car - All parking violations. Through private property or alley to avoid a traffic device.

The following are $1 fines.
Truck on boulevard - Improper horn equipment - Lights, all violations - No mirror on truck - No red flag or light on projection or towline - No windshield cleaner - No chauffeur's badge - Motor running unattended - Excessive smoke - Plates missing from car or trailer - Dirty or obscure plates - No receipt of registration - No operator's license on person.

ENGINE PARTS

The engine is the heart of the car--its most important unit--and therefore the purpose of the first series of sheets is to familiarize the student with its most important parts. The principal parts of the V-8 engine, their purpose, and their construction are as follows:

CRANKSHAFT

1. Purpose. To operate the other parts of the engine and convey the power to the clutch (Fig. 1).
2. Material. Carbon-copper, chrome-silicon alloy steel.
3. Type. 90°. Counterbalanced.

CRANKSHAFT MAIN BEARING

1. Purpose. To provide a bushing between crankshaft and cylinder block (Fig. 1).
2. Material. Special alloy-steel backed.
3. Type. Replaceable.

FLYWHEEL

1. Purpose. To smooth out the power flow to the clutch and reduce vibration (Fig. 1).
2. Material. Cast iron.
3. Type. Centrifugal and balanced.

CRANKSHAFT AND CAMSHAFT GEARS

1. Purpose. To rotate the camshaft at half the speed of the crankshaft (Fig. 1).
2. Material. Crankshaft gear is steel and camshaft gear is bakelized fabric or aluminum.
3. Type. Helical.

CAMSHAFT

1. Purpose. To open the valves at the proper intervals (Fig. 1).
2. Material. Cast iron for strength.

ENGINE PAN

1. Purpose. To provide an oil reservoir for the engine (Fig. 1).

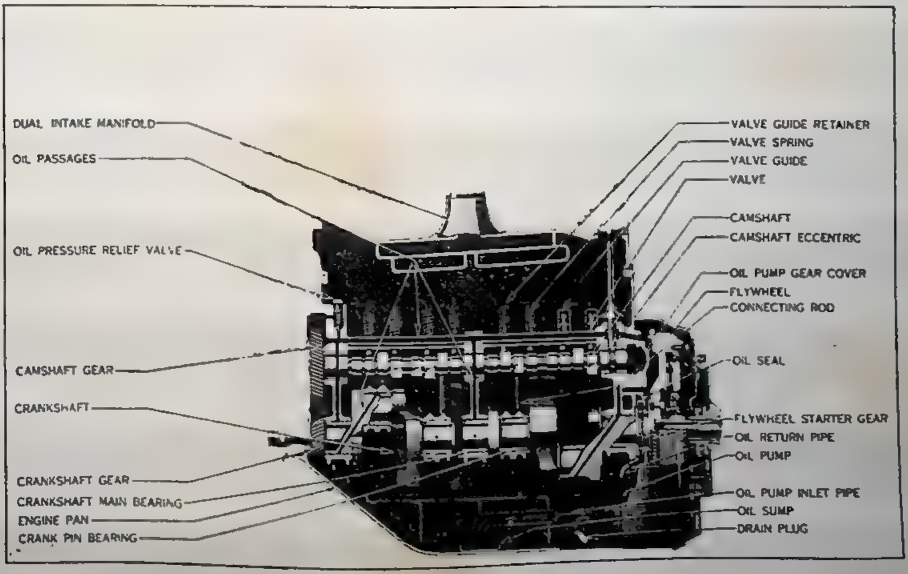


Fig. 1 Longitudinal Sectional View of Engine

PISTON PINS

1. Purpose. To connect the pistons with the connecting rods (Fig. 2).
2. Material. Machined seamless steel tubing.
3. Type. Floating in connecting rod and piston with retainer ring in end of piston pin hole to control the end play.

CONNECTING RODS

1. Purpose. To connect the pistons with the crankshaft and change the reciprocating motion of the pistons to the rotary motion of the crankshaft (Fig. 2).
2. Material. I-Beam, carbon manganese steel forgings.
3. Type. Side by side.

CONNECTING ROD (CRANK PIN) BEARINGS

1. Purpose. To provide a bushing between connecting rod and crankshaft (Fig. 2).
2. Material. Special bearing alloy.
3. Type. Replaceable full-floating (carried between ~~two~~ films of oil), with internal and external bearing surfaces.

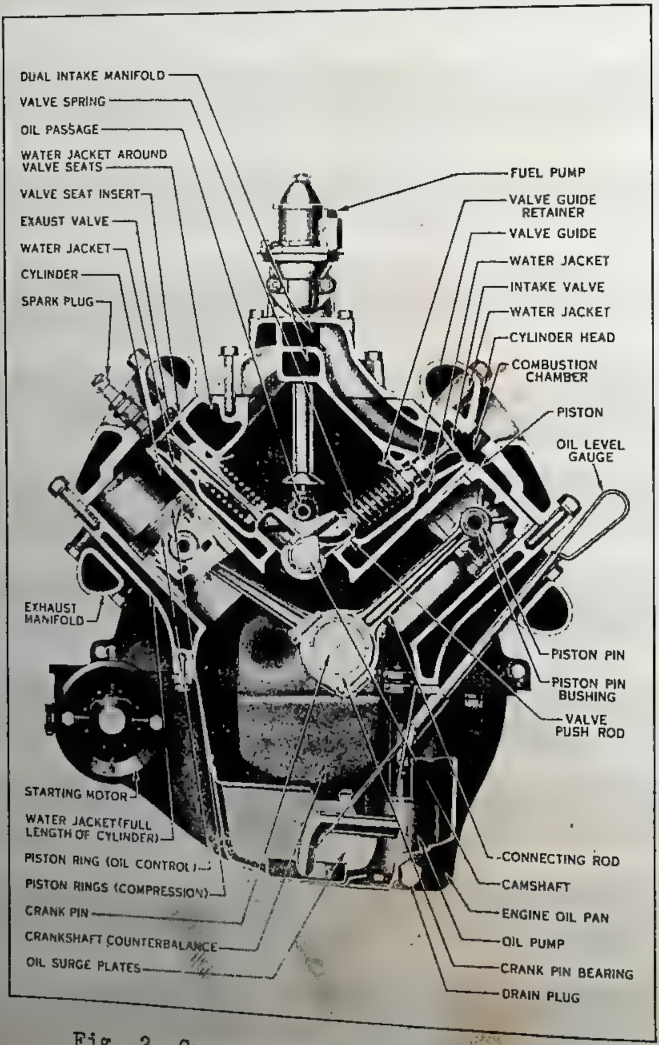


Fig. 2 Cross Sectional View of Engine

ENGINE

CYLINDER BLOCK

1. Purpose. To provide cylinders for the pistons to operate within, water jackets for cooling, and bearings for the moving parts.
2. Material. Cast alloy iron.
3. Type. 90° Vee, for shortness and compactness, thus occupying less chassis space; and cylinders, exhaust passages and crankcase cast integral, for rigidity and perfect alignment of cylinders, resulting in longer bearing life.

CYLINDER HEADS

1. Purpose. To provide the cylinders with combustion chambers for compressing and burning the fuel (gasoline). These chambers are also surrounded by water jackets for cooling (Fig. 2).
2. Material. Cast alloy iron.
3. Type. High compression--more power with regular fuel.

PISTONS

1. Purpose. To provide moving surfaces for the combustion pressure (Fig. 2).
2. Material. Cast alloy steel--for lightness, less vibration, and less cylinder wear. This reduces friction and carbon, increasing power and car acceleration.
3. Type. Full skirt.

PISTON RINGS

1. Purpose. To seal the gap between the piston and cylinder, and to wipe off excess oil on the cylinder (Fig. 2).
2. Types. Two compression rings and one oil control ring.

VALVE PUSH RODS

1. Purpose. To convey the camshaft lift to the valves (Fig. 2).
2. Material. White cast iron.
3. Type. Non-adjustable, and hollow for lightness.

VALVES

1. Purpose. To permit the intake of the fuel mixture, its compression, and the exhaust of burned gas from the cylinders (Fig. 2).
2. Material. Chrome-nickel alloy steel, for heat resistance and non-warping.
3. Type. Mushroom ends to reduce wear and noise.

VALVE GUIDES

1. Purpose. To provide a bushing between valve stem and cylinder block (Fig. 2).
2. Material. Gray cast iron.
3. Type. Split to permit the use of mushroom end valves.

VALVE SPRINGS

1. Purpose. To close the valves (Fig. 2).
2. Material. Spring steel.
3. Type. Coil.

VALVE SEAT INSERTS

1. Purpose. To lengthen the time between valve grinds by providing a harder surface for the valve seat (Fig. 2).

AUTOMECHANICS

SERIES 1

Group A

Corrected by No.________

No.________Name ____________________

Class__________Score____________________
(No. Right)

Answer the following without using the pictures.

1. Name three metals used for engine parts that contain the letter M.

2. Name one non-moving part of the engine of which there is more than one.

3. Name four rotating parts of the engine of which there is more than one.

4. Which two moving non-rotating parts of the engine have two-word names?

5. Which type of piston rings are the least in number?

6. Name two moving parts of the engine of which there is only one of each, that depend upon the crankshaft gear for their motion.

7. Which shaft revolves slower, the camshaft or the crankshaft?

8. Name two non-moving parts of the engine that require no lubrication.

9. Name one moving part of the engine that would most likely fail first from lack of lubrication.

10. Name four moving parts of the engine of which there is more than one.

Grade

A	B	C	D

ENGINE

The purpose of the second series of sheets is to familiarize the student with a few of the V-8 engine specifications.

A. Type 90 degree V-8	85 H.P.	95 H.P.
B. Bore	3.062	3.185
C. Stroke	3.75	3.75
D. Compression ratio	6.15 to 1	6.15 to 1
E. Piston displacement	221 cu. in.	239 cu. in.
F. Compression pressure at:		
(1) 100 R.P.M.	100 pounds	100 pounds
(2) 2200 R.P.M.	135 pounds	145 pounds
G. Taxable horsepower rating	30	32.5
H. Brake (running) horsepower	85 at 3800 R.P.M.	95 at 3600 R.P.M.
I. Firing order 1-5-4-8-6-3-7-2		

EXPLANATION

A. The engine has two banks of four cylinders, set at an angle of 90°.

B. The bore of the cylinder is the diameter.

C. The stroke of the piston is the distance it travels in the cylinder.

D. The compression ration is defined as the total volume of gas in the cylinder and combustion chamber when the piston is at the bottom of the stroke compared to the total volume of gas in the combustion chamber when the piston is at the top of the stroke.

E. The piston displacement is the volume of gas displaced during the piston stroke. The formula for computing the piston displacement for one cylinder is

$$(\text{bore})^2 \times .7854 \times \text{stroke}.$$

F. Compression pressure is the maximum pressure within the cylinder, and varies with engine speed.

G. The formula for computing the taxable horsepower for one cylinder is

$$\frac{(\text{bore})^2}{2.5}$$

H. Brake horsepower is the power delivered to the crankshaft, and varies with the engine speed. A dynamometer is used for measuring brake horsepower.

I. The firing order of the engine is the order in which the cylinders produce power. The cylinders are numbered on each side from the front to the rear, one to four on the right side and five to eight on the left side.

AUTOMECHANICS

SERIES 2

Group A

No.________ Name____________________

Class__________ Score______________
(No. Right)

Corrected by No.________

Answer the following.

1. How would a change in the bore of the cylinder affect the compression ratio?

2. How would a change in the compression ratio affect the piston displacement?

3. How would a change in the stroke of the piston affect the displacement?

4. Compute the piston displacement of the 85 H.P. engine. Bore = 3.062 and stroke = 3.75. (Use formula and show work.)

5. What is the compression pressure at 1050 R.P.M.? (Show work.)

6. Compute the taxable horsepower of the same engine in problem four. (Use formula and show work.)

7. How would a change in the compression ratio affect the horsepower?

8. How would a change in the bore of the cylinder affect the horsepower?

9. When piston number one is starting its power stroke, which piston is starting its exhaust stroke?

10. What would be the firing order of the engine if the left bank of cylinders were numbered one to four, starting at the front, and the other bank were numbered five to eight, starting at the front?

Grade

A	B	C	D

H F T S AUTOMECHANICS GREENFIELD VILLAGE TOUR TEST

Answer one of the following groups of questions on the opposite side of this sheet from memory.

GROUP A

1. Name four types of agricultural implements seen in the Edison Museum.
2. Describe the interior of the Sandwich glass plant.
3. Describe the interior of the Plymouth carding (weaving) mill.
4. Describe the interior of the blacksmith shop.
5. Describe the interior of the tintype studio.
6. What does the Waterford general store have that a modern chain store does not have? (Give four answers.)
7. Describe the Clinton Inn.
8. What is the name of the steamer (boat)?
9. Describe the first floor of the Edison Menlo Park laboratory.
10. What does the Cotswold (sheperd's) cottage have that your home does not have? (Give four answers.)
11. Describe the Sir John Bennett jewelry store.
12. Name four buildings entered that were erected in memory of some person.

GROUP B

1. Name four types of vehicles seen in Edison Museum.
2. Describe the interior of the Loranger grist (flour) mill.
3. Describe the interior of the Hanks silk mill.
4. Describe the interior of the Kingston cooper (barrel) shop.
5. Describe the interior of the post office.
6. What does a modern chain store have that the Waterford general store does not have? (Give four answers.)
7. What is the name of the chapel and why was it so named?
8. What four things were of special interest in the Logan County court house?
9. Describe the second floor of the Edison Menlo Park laboratory.
10. Describe the Edison Fort Myers laboratory.
11. What does your home have that the Cotswold (sheperd's) cottage does not have? (Give four answers.)
12. Name four buildings entered that had machinery in operation.

GREENFIELD VILLAGE TOUR TEST AUTOMECHANICS H F T S

No. ________ Name ____________________

Group ____________
(A or B)

Class ______________ Score __________
(No. Right)

Corrected by No. ________________

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

11.

12.

Grade

A	B	C	D

AUTOMECHANICS

No.________ Name________________________

Class____________ Score____________

(No. Correct)

INSPECTION AND SERVICE TEST

Answer the following.

1. Name five parts of an old car that are serviced free.

2. Name five parts of a new car that are likely to need adjusting first.

3. Name five parts of a new car that are likely to fail if the car is not given a regular inspection and servicing.

4. When an old car uses too much oil, what engine parts need replacing?

5. When the brakes of an old car become dangerously poor, what parts usually need replacing?

GENERAL TEST

1. Name five liquids used in a Ford V-8 besides gasoline, water, oil, or grease.

2. Name five electrical devices of a Ford V-8 besides accessories, lights, and gages.

3. Name five exposed parts of a Ford V-8 that are made of rubber besides tires, tubes, and running boards.

4. Name five parts of a Ford V-8 that are neither glass, metal, nor rubber.

5. Name one set of Ford V-8 parts that are triplets (exactly alike).

Corrected by No.__________

AUTOMECHANICS

No.________Name____________________

Class_________ Score ___________
(No. Correct)

INSPECTION AND SERVICE TEST

Answer the following.

1. Name five parts of a new car that are serviced free only during the guarantee period.

2. Name five parts of an old car that require a regular inspecting and servicing (not free).

3. Name five parts of a new car that wear out first.

4. What part of the clutch usually needs replacing first?

5. When the rear axle of an old car becomes noisy, what parts usually need replacing?

GENERAL TEST

1. Name five Ford V-8 gages or instruments.

2. Name five metals used in a Ford V-8 besides iron, steel, and alloys.

3. Name five glass parts of a Ford V-8 besides windows and lights.

4. Name one set of Ford V-8 parts that are twins (exactly alike).

5. Name one set of Ford V-8 parts that are quadruplets (exactly alike).

Corrected by No.________

E F T S

AUTOMECHANICS

No. ________ Name ____________________

Class ____________ Score ____________
(No. Correct)

COMPARISON TEST

List the comparisons between the following combinations. (NOTE: No two alike.)

	Tudor	Fish
1.		
2.		
3.		
4.		
5.		

	Fordor	Bird
1.		
2.		
3.		
4.		
5.		

ALPHABETICAL TEST

Name five automobile parts whose names begin with each of the following letters.

A

B

C

D

E

F

G

H

I

J

K

L

Corrected by No.____________

No. ________ Name ______________

Class ______________ Score ________

COMPARISON TEST

List the comparisons between the following combinations. (NOTE: No two alike.)

	Coupe	Human
1		
2		
3		
4		
5		

	Convertible	Animal
1		
2		
3		
4		
5		

ALPHABETICAL TEST

Name five automobile parts whose names begin with each of the following letters.

M ________

N ________

O ________

P ________

Q ________

R ________

S ________

T ________

U ________

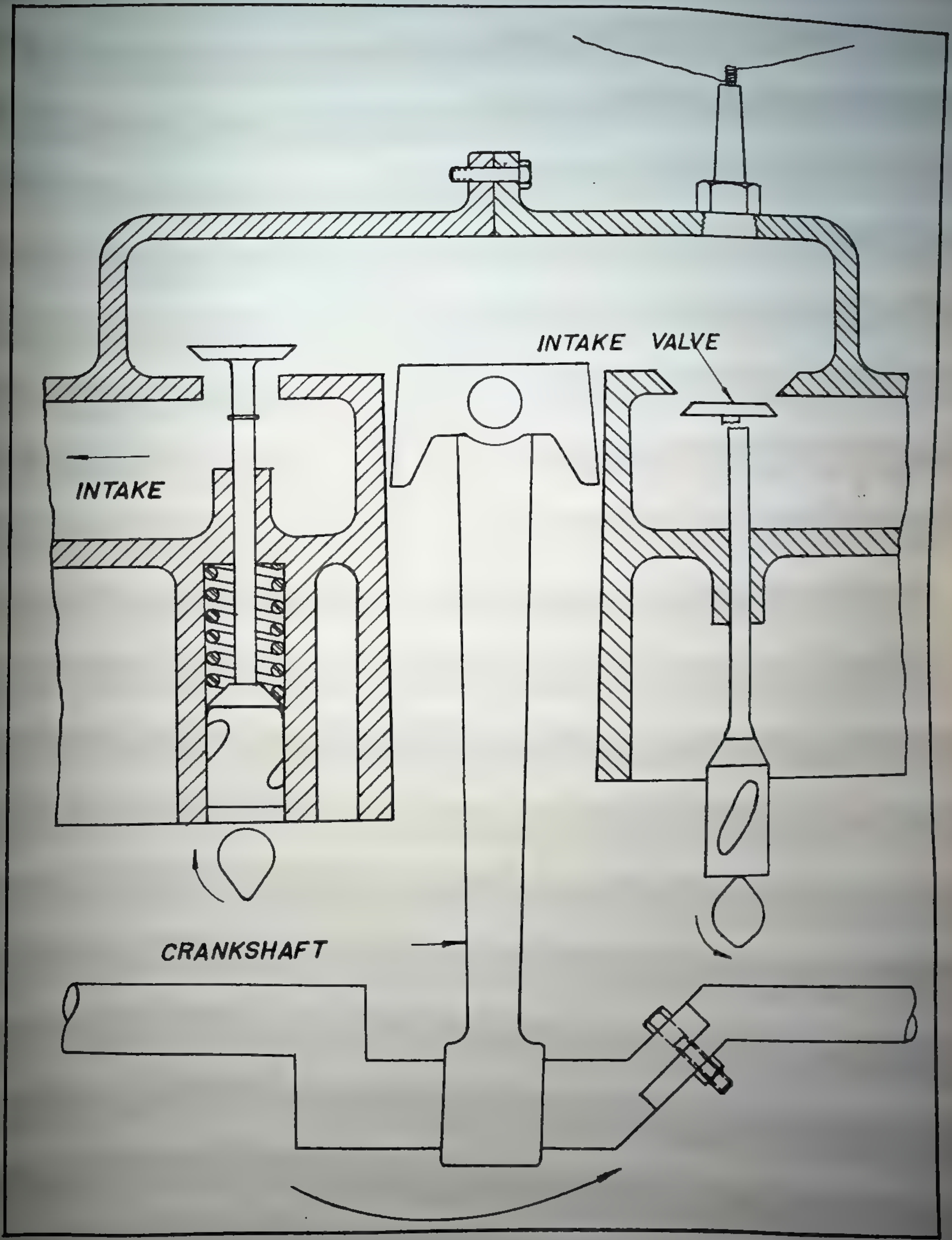
V ________

W ________

Y ________

Corrected by No. ________

ENGINE TEST



Number the errors in the above print and write the correction in the proper space on the opposite side of this sheet.

AUTOMECHANICS

ENGINE TEST No.__________ Name____________________

Answers Class____________ Score____________
(No. Correct)

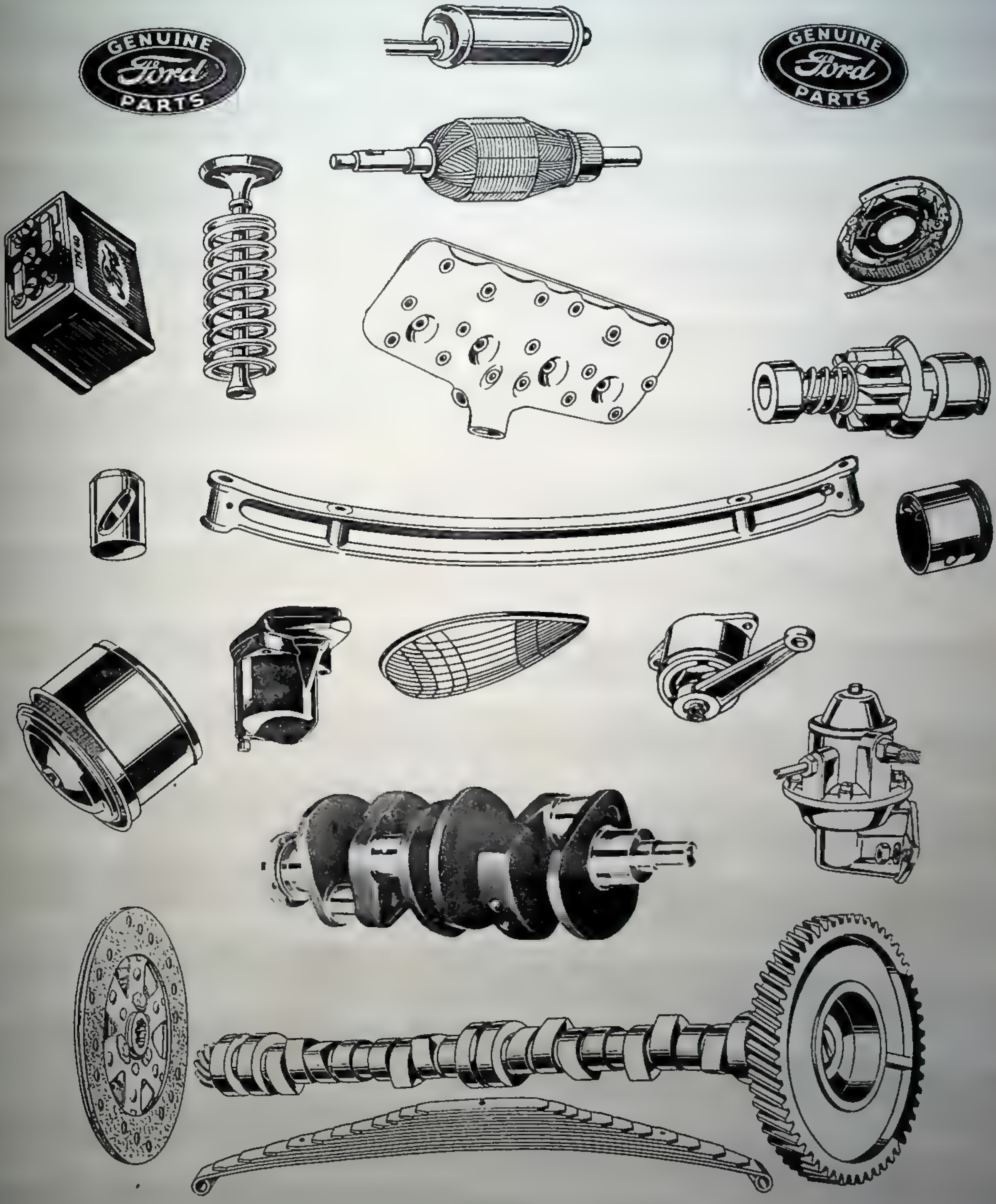
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	

Corrected by No.________

AUTOMECHANICS

CHASSIS TEST

Number the following parts (1 to 20), and then name and give the purpose of each in the proper space on the opposite side of this sheet.



AUTOMECHANICS

CHASSIS TEST

Answers

No.________ Name________________

Class__________ Score__________
(No. Correct)

NO.	NAME	PURPOSE
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Corrected by No.______

AUTOMECHANICS

No.________ Name______________________

Class__________ Score____________
(No. Correct)

TROUBLE TEST

Answer the following.

1. Number the following chassis troubles in the order in which they most frequently occur.

Broken Spring   Front Wheels not in Alignment   Squeaks

2. Number the following causes for an engine failing to start, in the order in which they most frequently occur.

Switch Off   Out of Gasoline   No Spark

3. Number the following causes for loss of engine compression, in the order in which they most frequently occur.

Warped Valves   Loose Spark Plugs   Broken or Weak Valve Springs

4. Number the following causes for the engine overheating, in the order in which they most frequently occur.

Broken Water Pump   Thermostats   Radiator Water Low

5. Number the following causes for the failure of the engine lubricating system, in the order in which they most frequently occur.

Lack of Oil   Pump Screen Clogged   Too Heavy Oil

6. Number the following fuel system troubles in the order in which they most frequently occur.

Fuel Line Clogged   Pump Diaphragm Split   Water in Fuel

7. Number the following causes for the starter failing to operate, in the order in which they most frequently occur.

Weak Battery   Starter Locked   Battery Connection

8. Number the following causes for the generator failing to charge, in the order in which they most frequently occur.

Dirty Generator   Fuse Blown   Loose Connections

9. Number the following causes for the lights failing to light, in the order in which they most frequently occur.

Fuse Burned Out   Switch   Battery Dead

10. Number the following causes for the ignition system failing to operate, in the order in which they most frequently occur.

Shorted Condenser   Ignition Coil   Ignition Switch

Corrected by No.________

AUTOMECHANICS

No.________Name________________

Class__________Score____________
(No. Correct)

TROUBLE TEST

Answer the following.

1. Number the following chassis troubles in the order in which they most frequently occur.

   Chattering Brakes
   Front Wheel Shimmy
   Hard Steering

2. Number the following causes for an engine failing to start, in the order in which they most frequently occur.

   Battery Weak
   Flooded Carburetor
   Starter Stuck

3. Number the following causes for loss of engine compression, in the order in which they most frequently occur.

   Worn Piston Rings
   Blown Cylinder Head Gasket
   Valves Stuck

4. Number the following causes for the engine overheating, in the order in which they most frequently occur.

   Radiator Frozen
   Radiator Clogged
   Spark Out of Time

5. Number the following causes for the failure of the engine lubricating system, in the order in which they most frequently occur.

   Pump Broken
   Leaking Oil Line
   Faulty Gauge

6. Number the following fuel system troubles in the order in which they most frequently occur.

   Carburetor Floods
   Pump Screen Clogged
   Poor Fuel

7. Number the following causes for the starter failing to operate, in the order in which they most frequently occur.

   Switch
   Starter Spring
   Ground Connection

8. Number the following causes for the generator failing to charge, in the order in which they most frequently occur.

   Cutout Stuck
   Faulty Ammeter
   Burned Out Generator

9. Number the following causes for the lights failing to light, in the order in which they most frequently occur.

   Bulb Burned Out
   Wiring
   Faulty Socket

10. Number the following causes for the ignition system failing to operate, in the order in which they most frequently occur.

    Breaker Points
    Spark Plugs
    Wiring

Corrected by No.________

AUTOMECHANICS

No.__________Name_______________________

Class____________Score________________
(No. Correct)

MOTOR ASSEMBLY TOUR TEST

Answer the following.

1. Is the camshaft (timing) gear made of metal, rubber, fabric, or wood? Why?

2. Name four parts of the engine that are assembled to the cylinder block when it is upside down.

3. What are the chief purposes of giving the engine a running (block) test? Give two answers.

4. Name two moving engine parts that are automatically inspected?

5. Give four ways in which the Ford and Mercury engines are alike besides having similar parts.

CAR ASSEMBLY TOUR TEST

1. At what three points along the assembly line were hoists used?

2. Name four parts of the chassis that are assembled to the frame when it is upside down.

3. In what order are the following put into the car? (Indicate with numbers.)
   Alcohol Water Anti-rust Liquid Gasoline

4. Underline the following body colors that were seen.
   Black Brown Green
   Blue Gray Maroon

5. How do the Ford and Mercury cars differ besides in name, size, and horsepower? Give four answers.

Corrected by No.__________

No.__________Name______________________

Class__________Score______________

(No. Correct)

MOTOR ASSEMBLY TOUR TEST

Answer the following.

1. In what order are the following parts assembled to the cylinder block? (Indicate with numbers.)

   Connecting Rods   Crankshaft   Flywheel   Valves

2. Name four parts of the engine that are assembled to the cylinder block when it is setting on its rear end.

3. Name two rotating engine parts that are balanced.

4. Name two moving non-rotating engine parts that are weighed and assembled in sets.

5. How do the Ford and Mercury engines differ besides in horsepower, size, and having similar parts? Give four answers.

CAR ASSEMBLY TOUR TEST

1. What part of the car starts the final assembly? Why?

2. In what order are the following parts attached to the unfinished cars? (Indicate with numbers.)

   Bumpers   Steering Gear   Radiator   Engine

3. Underline the following types of cars that were being assembled.

   Tudor
   Fordor
   Coupe
   Club Coupe
   Convertible Coupe
   Convertible Fordor

4. How does a de luxe car differ from a standard one. Give four answers.

5. Give four ways in which the Ford and Mercury cars are alike besides having similar parts.

Corrected by No.__________

H F T S

AUTOMECHANICS

No.________ Name________________

Class________ Score________
(No. Correct)

COMPLETION TEST

Fill in the spaces with the proper words.

1. Cugnot built the first s__________ car.
2. Morrison built the first e__________ car.
3. Benz's car had o__________ cylinder.
4. Duryea's car had f__________ wheels.
5. Ford Motor Company has built over t________-________ million cars.
6. An automobile without a body is called a c__________.
7. The two most important chassis units are r________ g________ and p________ p________.
8. The most popular types of bodies are t________, f________, and c________.
9. Standard body equipment includes w________ w________, m________, a________ t________, and s________.
10. De luxe equipment includes two s________ v________ and a________ c________.
11. Body accessories include r________ and s________ m________.
12. Chassis accessories include h________ and b________.
13. Body windows open v__________.
14. Body colors are b________, b________, and b________.
15. Materials used for glass are s________ and l________.
16. The center of a piece of safety glass is c________ a________.
17. The distance between the front wheels is called the t__________.
18. The distance between the left wheels is called the w__________.
19. The s________, t________, and s________ a________ make a car ride smoothly.
20. The t________ t________ transmits the driving thrust of the rear wheels to the frame.
21. Ford type springs are t__________.
22. The front wheels are set b__________.
23. C__________ causes a car to straighten out after a turn.
24. The d________ l________ joins the right wheel and steering gear.
25. The safety of a car depends chiefly on the d________ and b________.
26. The Ford V-8 has super safety h________ and m________ brakes.
27. Automobile engines are internal c________ four s________ type.
28. The v________ and p________ are moving parts of the engine.
29. When the piston is going down it is on the i________ or p________ stroke.

COMPLETION TEST (CONTINUED)

30. The three heaviest parts of the engine are f__________, c__________, and c__________ b__________.

31. The chief parts of the fuel system are t__________, p__________, c__________, and g__________.

32. The carburetor and s__________ g__________ operate on the same principle.

33. The water in the cooling system is heated in the e__________ j__________.

34. Radiator anti-freeze solutions are a__________ and e__________ g__________.

35. The chief cause of wear in an engine is f__________.

36. The cylinders and pistons of a Ford V-8 are oiled by a s__________.

37. A Ford V-8 has one o__________ pump and two w__________ pumps.

38. The transmission is used for p__________ and p__________.

39. The purpose of the clutch is for g__________ s__________.

40. The d__________ permits the rear wheels to revolve at different speeds.

41. Electrical pressure is called v__________.

42. The electrical system is energized with d__________ current electricity.

43. Less voltage causes less c__________ to flow.

44. A piece of steel which attracts another piece of steel is called a m__________.

45. The strongest parts of a magnet are its p__________.

46. Like poles r__________.

47. Two south poles r__________.

48. A n__________ and s__________ pole a__________.

49. The positive plates are b__________.

50. The electrolyte is a s__________ acid solution.

51. The negative plates are made of s__________ l__________.

52. A b__________ changes chemical energy into electrical energy.

53. The chief purpose of the generator is to charge the b__________.

54. The charging rate of the two-brush type of Ford V-8 generator is changed a__________.

55. The s__________ changes electrical energy into mechanical energy.

56. The armature c__________ and field p__________ of the starter produce its magnetism.

57. The four most important lights on a Ford V-8 are the h______, t______, and l______.

58. Single filament bulbs are used in the p______, l______, and p______ lights.

59. The ignition system receives its power from the b__________ and the g__________.

60. The spark should occur at the completion of the c__________ stroke.

Corrected by No.__________

HFTS

AUTOMECHANICS

No. ________ Name ____________________

Class __________ Score ________________
(No. Correct)

COMPLETION TEST

Fill in the spaces with the proper words.

1. Benz built the first g____________________ car.
2. Duryea built the first A____________________ gasoline car.
3. Cugnot's car had t______________ wheels.
4. Ford's first car had t______________ cylinders.
5. Approximately e______________ million Ford cars are registered in the U. S.
6. The two major parts of an automobile are b______________ and c______________.
7. The two least important chassis units are c______________ and e______________.
8. The most popular upholstering materials are m______________ and b__________ c__________.
9. Standard body equipment includes s________ v____________, c__________ l__________, o__________ g__________, and f__________ g__________.
10. De luxe equipment includes two w____________ w____________ and a c______________.
11. Body accessories include s____________ l____________ and e____________ c____________.
12. Chassis accessories include r____________ l____________ and o____________ f____________.
13. Body windows open h______________.
14. Body colors are b__________, g__________, b__________, and m__________.
15. Materials used for glass are s__________ g__________, s__________ a__________, and s__________ c__________.
16. A c______________ mixture is between the glass and the acetate.
17. The distance between the rear wheels is called the t______________.
18. The distance between the right wheels is called the w______________.
19. The r__________ r__________ brace the axles.
20. The s__________ a__________ control the spring movement.
21. The distance between the springs is called the s______________.
22. The front wheels are p__________ t__________.
23. The t__________ r__________ joins both front wheels.
24. Too much t________-________ or t________-________ causes tire wear.
25. Good brakes should decelerate a car t______________ miles per hour per second.
26. The Ford V-8 has two-wheel e______________ and four wheel s______________ brakes.
27. Automobile engines are ______________ type or straight (in line).
28. The c______________ and f______________ are rotating parts of the engine.
29. When both valves are closed the piston is on the c__________ or p__________ stroke.

COMPLETION TEST (CONTINUED)

30. The e________ p________, c________ b________, and c________ h________ are non-moving parts of the engine.

31. Air and fuel are mixed in the c________.

32. The exhaust gas contains deadly c________ m________.

33. Heat inside the engine is caused by c________, f________, and c________.

34. The heated water in the engine becomes cooler in the r________.

35. Friction is an advantage at the b________, t________, and c________.

36. Oil becomes thinner when h________ and thicker when c________.

37. A Ford V-8 has f________ pumps.

38. The transmission is used for s________ and r________.

39. The purpose of the clutch is for s________ s________.

40. The Ford V-8 has a t________-q________ floating rear axle.

41. Electrical current is called a________.

42. More pressure causes more c________ to flow.

43. Direct current is a c________ current.

44. The power in a magnet is called m________.

45. There are two kinds of magnets, p________ and e________.

46. The poles are named n________ and s________.

47. The north poles r________.

48. Unlike poles a________.

49. The chemical reaction within a battery is between the p________ and e________.

50. The n________ plates are g________.

51. The positive plates are made of l________ p________.

52. S________ are placed between the plates.

53. A g________ changes mechanical energy into electrical energy.

54. The charging rate of one type of Ford V-8 generator is changed by shifting the top b________.

55. The Ford V-8 wiring system is of the s________ wire and g________ type.

56. The principal parts of the starter are the a________, b________, and f________.

57. The head-light u________ beam is for fast driving, and the l________ beam is for passing or slow driving.

58. The compressed charge of gas inside the cylinder is ignited by a s________.

59. Double filament bulbs are used in the h________-________ and t________ lights.

60. The low voltage battery current is increased to a high voltage by the c________.

Corrected by No.________

H F T S

AUTOMECHANICS

TRUE-FALSE TEST

No.________Name____________________

Class__________Pluses______________

Minuses______________

Total______________

If a statement is true, change the sign to plus.

(-) The first automobile is about 170 years old.

(-) Early automobiles were powered with steam engines.

(-) Mr. Ford built one of the first gasoline cars in the United States in 1896.

(-) The first sale of an American gasoline car was made about 40 years ago.

(-) There were approximately 200 automobile manufactures in 1903.

(-) The Ford Motor Company was organized in 1903.

(-) There have been over 1500 makes of American cars.

(-) Today there are about 20 American makes of cars besides Ford and Lincoln cars.

(-) The Ford Motor Company has built over 26 million cars.

(-) The automobile is made up of two major parts, body and chassis.

(-) The chassis is divided into four divisions.

(-) Most cars are constructed on the same principles.

(-) Most cars are alike in certain respects and yet they differ.

(-) There are 12 body types for Ford cars.

(-) There are four types of body upholstering.

(-) Bodies have three-way ventilation.

(-) There are six standard body colors.

(-) There are five chief materials used in making glass.

(-) The most important part of the running gear is the frame.

(-) The Ford V-8 frame is of the X-type double drop and channel steel construction.

(-) The good riding qualities of a chassis depend largely upon the tires, the springs, and the shock absorbers.

(-) Springs are not made of cast iron or soft steel.

(-) Ford V-8 cars have transverse, double tapered, leaf springs.

(-) Automobile axles hold the wheels in place.

(-) Wagon and automobile front axles are of the dead type.

(-) Wagon and automobile axles serve the same purpose.

(-) The Ford V-8 front axle is of the I-beam type.

(-) With the dead type of axle the wheels revolve on the axles, and with the live type the axles revolve with the wheels.

(-) The distance between the rear wheels is called the tread.

(-) The wheelbase is the distance between the axle centers.

(-) Most American built cars have a left-hand drive.

(-) The Ford V-8 steering system has a gear ratio of 18.2 to 1.

(-) The front wheels are not parallel with the rear wheels or with each other.

(-) The front wheels are closer together at the bottom to place the front weight on the large inner wheel bearings.

(-) The front wheels are closer together at the front to reduce tire wear to a minimum and to counteract high speed wheel spread (called toe-out).

(-) The spindles are castered to make turning easier and to keep the wheels in a straight line.

(-) The most important sets of automobile controls are the steering and the braking systems.

(-) Ford cars have mechanically operated, two wheel emergency (hand) brakes.

(-) Ford cars have hydraulic operated four wheel service (foot) brakes.

(-) Most modern cars are powered with gasoline engines.

(-) The Ford V-8 engine operates on the four-stroke principle.

(-) Piston rings, piston pins, and valve springs are moving parts of an engine.

TRUE-FALSE TEST

(-) Combustion and explosion are not the same.
(-) The four strokes in reverse order are: exhaust, power, compression, and intake.
(-) During none of the four strokes are both valves open.
(-) During two of the four strokes both valves are closed.
(-) During two of the four strokes one valve is open.
(-) During the exhaust and compression strokes the piston is coming up.
(-) During the power and intake strokes the piston is going down.
(-) The Ford V-8 is equipped with a fuel pump.
(-) The fuel pump is not operated by hand.
(-) Water in gasoline causes more trouble in the winter than in the summer.
(-) The principle of the carburetor and the mouth sprayer is the same.
(-) One tablespoonful of gasoline requires about 35 gallons of air to vaporize it before it is burned.
(-) Carbon monoxide gas is poisonous when inhaled outside of a garage.
(-) Combustion, compression, and friction are the sources of heat in an engine.
(-) The chief purposes of the cooling system are to prevent scoring of the cylinders and seizing of the moving parts.
(-) The water in the radiator flows into the engine at the bottom to absorb heat.
(-) The water in the engine flows into the radiator at the top to be cooled.
(-) The cooling system requires less attention in summer than in winter.
(-) Parking in the winter is the chief reason for using an anti-freeze in the cooling system.
(-) Alcohol is not necessary when running the engine in the winter.
(-) Ten quarts of alcohol in the Ford V-8 cooling system is sufficient for winters in Detroit.
(-) Loss of power due to friction is about 5%.
(-) The brakes and clutch are not anti-friction devices.
(-) Approximately one pint of each gallon of fuel is used in overcoming the running friction of a car.
(-) Modern cars have forced circulation for engine lubrication.
(-) Good oil of the wrong grade is as bad as poor oil of the right grade.
(-) The crankshaft in the Ford V-8 engine is drilled for lubrication.
(-) The transmission of a car is the gear box.
(-) The purpose of the transmission is to reverse the car.
(-) Most cars have four speed transmissions.
(-) Modern cars have a standard gear shift.
(-) Ford V-8 cars have a synchronized shift and all speeds are silent.
(-) The clutch is located behind the fan.
(-) Modern cars have clutches of the dry disc type.
(-) Most cars have single plate clutches.
(-) The clutch is located in front of the transmission.
(-) The clutch is used for shifting gears.
(-) The clutch can disconnect or connect the engine with the transmission.
(-) When the clutch pedal is in the "in" position, the clutch disc is not clamped.
(-) Disengagement of the clutch occurs when the pedal is in the "in" position.
(-) A 3/4 floating rear axle carries none of the rear weight on the axle shafts.
(-) The differential allows the left rear tire to wear more than the right rear tire when making a right turn.
(-) If the right wheel revolves faster when backing around a corner, the left wheel will revolve slower when a forward turn is made around the same corner.
(-) The power through the differential is distributed equally to the wheels except when turning.

Corrected by No.__________

AUTOMECHANICS

TRUE-FALSE TEST

No.________ Name____________

Class__________ Pluses______

Minuses______

If a statement is true, change the sign to plus.

Total______

(-) The hand lever brake control should be used to stop the car only in an emergency.
(-) The hand lever brake control should be used when parked.
(-) The stopping distance of a car is the maximum distance in which the car should be stopped.
(-) The stopping distance increases with the speed.
(-) The distance required to stop a car varies with the load and the speed.
(-) A wire weighs the same with or without an electric current flowing through it.
(-) A wire need not be hollow for an electric current to flow through it.
(-) Electric pressure causes the current to flow.
(-) Current electricity must be direct or alternating.
(-) Electric current is measured in amperes.
(-) Electric pressure is measured in volts.
(-) Voltage causes the current to flow.
(-) Electricity, unlike magnetism, can be felt.
(-) Direct current, not unlike alternating current, can be produced mechanically.
(-) Both kinds of current cannot be produced chemically.
(-) Magnets will not attract gold, zinc, silver, or lead.
(-) Magnets will attract nickel, steel, cobalt, and iron.
(-) The poles of a magnet are near the ends.
(-) The center of a magnet is weaker than the poles.
(-) When a magnet is broken in two pieces, each piece has two poles.
(-) Electromagnets and permanent magnets are not made of the same metal.
(-) The poles of a magnet are not called positive and negative or plus and minus.
(-) A magnetized needle is a permanent magnet, while a magnetized pin is a temporary magnet.
(-) A magnetized pin should not be used for a compass.
(-) Two north poles repel.
(-) Two south poles repel.
(-) Two unlike poles attract.
(-) Two like poles repel.
(-) Electromagnets are unlike permanent magnets.
(-) An electromagnet becomes stronger with an increase in current or turns of wire.
(-) Magnetism is always present with current electricity.
(-) Electricity is not always present with magnetism.
(-) A piece of steel weighs the same before and after being magnetized.
(-) Not all batteries can be recharged.
(-) There are two types of batteries, wet and dry.
(-) Charging a storage battery does not mean storing electricity in it.
(-) Each cell of a storage battery produces approximately two volts.
(-) A storage battery cannot be charged with both kinds of current electricity.
(-) When charging a battery the current must go through the battery from the positive to the negative post.
(-) The chemical changes between plates and solution produce electricity.
(-) Separators do not insulate the plates.
(-) Storage battery plates are brown and gray.
(-) A Ford battery has 51 plates.
(-) A Ford battery has three more plates than separators.

TRUE-FALSE TEST

(-) A Ford battery has twice as many separators as positive plates.
(-) A Ford battery has three more negative plates than positive plates.
(-) The brown plates are fewer in number than the gray.
(-) The negative plates are gray.
(-) A fully-charged Ford V-8 battery would supply the ignition system with power for 32 hours, providing no other electrical equipment was in use.
(-) The most important branch of the electrical system is not the starting, lighting, or charging system.
(-) The purpose of the starting system is to crank the engine and not to start it.
(-) Starters are not connected directly to engine flywheels.
(-) All electrical systems are not grounded in the same manner; that is, some do not have a positive ground.
(-) A half-charged Ford battery would operate the starter continuously for 4 minutes.
(-) Starter wiring is not the same size as the other wiring.
(-) The electrical system of a car receives electricity from two sources.
(-) The battery supplies electricity when the generator is stopped.
(-) The maximum charging rate of a generator is 18 amperes.
(-) The generator charging rate should be about the same for summer night driving as for winter day driving.
(-) The chief purpose of the generator is to charge the battery.
(-) The ammeter measures the charging current of the generator and the discharging current of the battery.
(-) The generator cutout is quiet when open.
(-) The cutout prevents discharge of the battery when the engine is stopped.
(-) The regulator prevents the generator from overcharging the battery.
(-) The generator charging rate may be altered by shifting one of the brushes on it.
(-) All Ford cars are equipped with not less than four electric lights.
(-) Only three lights are necessary for night driving.
(-) When lights are connected in parallel, the burning out of one bulb has little effect on the others.
(-) Instrument and pillar lamp bulbs are of the same candle power.
(-) Headlights and parking lights are of different brilliancy.
(-) Single filament bulbs are single contact.
(-) Double filament bulbs have double contacts.
(-) Double filament bulbs provide a high and low speed driving beam.
(-) Headlight reflectors increase the intensity of the lights.
(-) The ignition system is the most important branch of the electrical system.
(-) Modern cars have battery ignition.
(-) The principal parts of the ignition system are the distributor and coil, battery, spark plugs, and breaker points.
(-) The coil increases the low voltage battery current to a high voltage current.
(-) The distributor delivers the high voltage coil current to the spark plugs at the proper time.
(-) The spark plugs supply the gap for the high voltage current to jump.
(-) The spark occurs at the finish of the first upward stroke.
(-) The spark occurs at the start of the second downward stroke.
(-) The spark occurs between the second and third strokes.
(-) The spark occurs between the compression and power strokes.
(-) The spark occurs at the finish of the stroke following the intake stroke.
(-) The spark occurs at the start of the stroke preceding the exhaust stroke.
(-) The spark control of a Ford V-8 is automatic.

Corrected by No.________

AUTOMECHANICS

MULTIPLE CHOICE TEST

No._______ Name _____________
Class _______ Score _____________
(No. Correct)

Encircle all correct answers (one or more) to the following questions.

1. Who built a gasoline car?

Benz   Duryea   Morrison

2. Which is a major part of a car?

Body   Controls   Power Plant

3. Which is the most important part of the running gear?

Axles   Radius Rods   Springs   Torque Tube

4. How are the front wheels set?

Camber   Horizontal   Parallel   Toe-out

5. Which engine parts rotate?

Connecting Rods   Engine Pan   Pistons

6. During which stroke are both valves closed?

Compression   Intake

7. Where in the fuel system is gasoline found?

Air Cleaner   Fuel Line   Pump

8. Where in the cooling system is water found?

Engine Jackets   Fan Belt   Radiator Fins

9. Where in the lubricating system is oil found?

Cylinder Heads   Pump

10. In which gear shift position has the car the most power?

Low   Reverse

MULTIPLE CHOICE TEST

11. Which should be operated when shifting gears?

Accelerator Clutch Pedal

12. Which permits the wheels to rotate at different speeds?

Axle Shaft Engine Steering System

13. Which are invisible?

Electricity Gasoline Magnetism

14. Which has both a pressure and a current?

Electricity Gravity

15. Which battery is rechargeable?

Dry Wet

16. Which produce electricity for the electrical system?

Ammeter Cigar Lighter Generator Ignition Radio

17. Which are in use when starting an engine?

Ammeter Battery Generator

18. Which are required by law?

Headlights License Light Stop Light

19. Which are the high voltage parts of the electrical system?

Ammeter Breaker Points Condenser Fuel Gauge Generator
Ignition Coil Oil Gauge Radiator Cap Starter

20. Upon which does the safety of the car chiefly depend?

Braking System Horn Steering System

Corrected by No.__________

H F T S

AUTOMECHANICS

MULTIPLE CHOICE TEST

No.________ Name__________________

Class__________ Score____________ (No. Correct)

Encircle all correct answers (one or more) to the following questions.

1. Who built a gasoline car?

Cugnot   Ford   Roper

2. Which is a major part of a car?

Chassis   Equipment   Running Gear

3. Which is the most important part of the running gear?

Frame   Shock Absorbers   Tires   Wheels

4. How are the front wheels set?

Caster   Off-set   Toe-in   Vertical

5. Which engine parts rotate?

Cylinders   Valve Push Rods   Valves

6. During which stroke are both valves closed?

Exhaust   Power

7. Where in the fuel system is gasoline found?

Carburetor   Fuel Gauge   Fuel Tank

8. Where in the cooling system is water found?

Fan   Pumps   Thermostats

9. Where in the lubricating system is oil found?

Engine Pan   Gauge

10. In which gear shift position has the car the more power?

Second   High

MULTIPLE CHOICE TEST

11. Which should be operated when shifting gears?

Brake Pedal
Gear Shift Lever

12. Which permits the wheels to rotate at different speeds?

Clutch
Differential
Transmission

13. Which are invisible?

Gas
Gravity
Water

14. Which has both a pressure and a current?

Magnetism
Water

15. Which battery is rechargeable?

Dry
Storage

16. Which produce electricity for the electrical system?

Battery
Cut-out
Horn
Lights
Starter

17. Which are in use when starting an engine?

Clutch
Ignition
Starter

18. Which are required by law?

Instrument Lights
Parking Lights
Tail Lights

19. Which are the high voltage parts of the electrical system?

Battery
Lights
Cigar Lighter
Radio
Cut-out
Spark Plugs
Fuse
Switches
Horn

20. Upon which does the safety of the car chiefly depend?

Driver
Lights
Windshield Wiper

Corrected by No.________

AUTOMECHANICS

No.________Name____________________

Class__________ Score__________
(No. Correct)

MATHEMATICS TEST

Compute the following problems. (Show work.)

1. How many times per second must each cylinder fire when the engine speed is 3600 revolutions per minute?

2. What is the horsepower and r p m of the engine at 45 miles per hour when the horsepower is 40 and the r p m is 1500 at a car speed of 30 m p h?

3. How many revolutions will a 6.00 inch tire make per mile if it is on a 16 inch wheel?

4. If it requires nine gallons of air to vaporize one teaspoonful of gasoline, how much air is required to vaporize one quart of gasoline (64 teaspoonsful equal one-half pint)?

5. How many revolutions will the drive shaft make per second when the rear axle ratio is 3.5 to 1, car speed 60 m p h, and tire and wheel size as in problem three?

EXCHANGE TEST

What is the chief cause for failure and exchanging each of the following parts?

1. Clutch disc

2. Carburetor

3. Shock Absorber

4. Generator

5. Distributor

Corrected by No.________

No.________ Name________________ ____

Class__________ Score____________
(No. Correct)

MATHEMATICS TEST

Compute the following problems. (Show work.)

1. How much more does the piston travel downward during the first half of the piston stroke than during the second half when the piston stroke is 6 inches, the connecting rod length is 5 inches, and the cylinder bore is 4 inches?

2. Which four cylinders could be disconnected in order to make a Ford V-8 engine run evenly on four cylinders? Firing order is 1-5-4-8-6-3-7-2.

3. How many revolutions will the engine make per mile in high gear if the rear axle ratio is 4 to 1, and the tire is 6.00 × 16 inches (wheel size)?

4. What is the piston speed in feet per second when the engine speed is 3600 r p m, and the stroke is 6 inches?

5. What is the inside rear wheel speed when turning a curve if the engine speed is 1750 r p m, the transmission is in high gear, the rear axle ratio is 3.5 to 1, and the outside wheel speed is 519 r p m?

EXCHANGE TEST

What is the chief cause for failure and exchanging each of the following parts?

1. Clutch Pressure Plate

2. Fuel Pump

3. Water Pump

4. Brake Assembly

5. Engine Assembly

Corrected by No.________

H F T S

AUTOMECHANICS

PROGRESS TEST

Answer one of the following groups of questions on the opposite side of this sheet.

GROUP A

1. Name ten chief parts of a car that are under the body.
2. What attention do the brakes require?
3. What attention does the engine require?
4. What carburetor controls are operated by the driver?
5. What attention does the cooling system require?
6. What attention does the lubricating system require?
7. What are the two purposes of the clutch?
8. What are the purposes of the transmission?
9. Name ten electrical devices on an automobile.
10. What attention do the axles require?
11. What is the purpose of the storage battery?
12. Name the part that charges the battery.

GROUP B

1. What parts under the body require attention?
2. Name ten moving parts of an engine.
3. How many wheels have brakes?
4. What attention does the carburetor require?
5. Name eight liquids used in automobiles.
6. How does the rear axle differ from the front axle?
7. What attention does the clutch require?
8. What attention does the transmission require?
9. What attention does the storage battery require?
10. What attention does the ignition system require?
11. Name four ways of starting an automobile engine.
12. What attention do the tires require?

PROGRESS TEST AUTOMECHANICS HFTS

Group ______ No. ________ Name ____________________
(A or B)

Corrected by No. ________ Class __________ Score __________
(No. Right)

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

11.

12.

Grade

A	B	C	D

H F T S

AUTOMECHANICS

Group A

Corrected by No.________

No.________ Name______________________________

Class____________ Score______________________
(No. Right)

Traffic Ordinance Test

If a statement is true, change the sign to plus.

(-) Speed limits in Detroit are: in alleys 15, business districts 25, and passing stopped cars 25.
(-) 30 miles per hour in second gear may not be speeding.
(-) A green light means stop if unsafe.
(-) Amber flashing lights mean the same as red flashing lights.
(-) A red light with a flashing red arrow means the same as a red flashing light.
(-) Crossing a railroad tract without stopping is lawful, except when the red flashing light is in operation.
(-) It is lawful to drive on the left side of the street, except at crossings, intersections, or when not passing.
(-) When a driver is turning into the moving traffic from the curb, he does not have the right-of-way.
(-) At the sound of a siren or bell on an approaching vehicle, drive to the right-hand curb and drive slowly.
(-) It is unlawful to follow a fire or police department vehicle or ambulance closer than 500 feet.
(-) Traffic on non-stop streets with car lines has the right-of-way over traffic on non-stop streets without car lines.
(-) Funeral prossessions need not stop for railroad red flashing lights or red lights.
(-) It is unlawful to leave the curb without signalling.
(-) Driving to the left of the center lane is unlawful.
(-) Straddling of lane markings is lawful except when it interferes with traffic.
(-) It is unlawful to overtake and pass a road hog on the right.
(-) Cutting in, to prevent a head-on collision after passing a car is unlawful.
(-) Passing a car on a curve is lawful except when the curve is a hill.
(-) Passing a street car on the left is lawful when traffic is blocked on the right.
(-) It is unlawful to pass a stopped automobile on the left except at an intersection.
(-) Driving through a gas station or private property to avoid a red light is lawful, but unlawful to avoid a no turn sign.
(-) Stopping is necessary before turning on a red light.
(-) If two cars are abreast when making a turn, the car on the inside has the right-of-way.
(-) Stopping is unnecessary when turning right on a green light.
(-) Turning left onto a one-way street on a red light is unlawful without stopping.
(-) Left turns are lawful from the street car tracks except at traffic lights or when a street car is approaching.
(-) Crossing a sidewalk without stopping is lawful when entering a gas station but not when leaving.
(-) Driving along a sidewalk is unlawful except when the street is impassable.
(-) Blocking cross traffic is unlawful except at intersections controlled by traffic signal lights.
(-) It is unlawful to cross a stop street without stopping except when there is no traffic near.
(-) A blind person with a seeing eye dog has the right-of-way and drivers must stop.
(-) It is lawful to drive through an unoccupied safety zone.
(-) Speed limit when passing a stopped street car at a car stop is the same as in alleys.
(-) Backing more than 60 feet is unlawful except when the street is blocked.

Grade

A	B	C	D

Traffic Ordinance Test

Group A

(-) It is unlawful to drive or back a car over a curb.
(-) Lap driving is unlawful except in the case of a minor.
(-) No driver or passenger shall have an arm around each other when the car is in motion, except to give the driver more room when three sit in the seat.
(-) Riding on the outside of a car is unlawful except where a person's occupation requires it.
(-) It is unlawful to drive with stickers on the windshield or windows.
(-) Reckless driving is more serious than drunk driving, according to the penalty.
(-) Maximum penalty for drunk driving is $500.00 fine and a jail term of 90 days.
(-) Parking at the east curb is unlawful on a winter afternoon when the sun shines on the left side of the car.
(-) Parking in front of a business driveway is lawful after closing hours.
(-) Parking between the sidewalk and curb is lawful in front of your own property.
(-) It is unlawful to park within 600 feet of a fire.
(-) It is unlawful to park within 30 feet of a flashing light or within 50 feet of a railroad track.
(-) It is lawful to park a car parallel with the curb when the right wheels are not more than 12 inches from the curb.
(-) It is lawful to park a car unlocked and unattended.
(-) Alley parking is lawful when there is no other place to park -- limit 5 minutes.
(-) Standing is permitted in no-parking areas.
(-) It is unlawful to park a car more than 48 continuous hours except if it is for sale or unable to run.
(-) Blinding headlights are lawful except when meeting another car.
(-) Parking without lights is lawful when the car is near a street light.
(-) The law requires four lights on a Ford car in use for night driving.
(-) It is unlawful to drive at night with only fog lights.
(-) Driving a car with defective brakes, steering system, bumpers, or windshield is unlawful.
(-) It is unlawful to use a horn instead of a door bell.
(-) It is unlawful to equip a car with a bell, siren, or whistle.
(-) Driving without a clear view of the rear in a mirror is unlawful except when the car is so loaded as to prevent it.
(-) It is lawful for a driver to conceal his identity, except to an officer or when involved in an accident.
(-) A minor is unable to obtain an instruction permit without being authorized by a parent or guardian.
(-) A student driver may not drive with passengers.
(-) It is unlawful to drive without the correct address on the license.
(-) Driving without a driver's license is unlawful, except by a tourist.
(-) The receipt of registration should be carried when driving.
(-) Descending a steep hill in gear with the clutch pedal "in" is coasting and is lawful.
(-) Signaling a driver by hand is not necessary when the stop light is in working order.
(-) When a police officer's orders conflict with the traffic ordinance, the officer's orders should be obeyed.
(-) It is unlawful to ride a passenger on the bar of a bike.
(-) A person with one arm is not allowed to ride a bike.
(-) A bike must be equipped with a warning device -- horn, siren or whistle.
(-) Passing an automobile on either side is lawful when in lanes.
(-) U-turns made at intersections are unlawful.
(-) Each car is entitled to half the street -- the right half.

HFTS

AUTOMECHANICS

Group A

No.________ Name______________________

Corrected by No.________

Class__________ Score__________________
(No. Right)

Driving Test

Encircle the correct answer.

1. If a pedestrian starts to cross the street at an intersection on the "Go" signal but the light flashes "Stop" before he reaches the other side, does he continue to have the right-of-way over vehicles until he gets across? YES NO
2. It is proper for a car to be operated anywhere on a street or road just as long as the driver stays to the right of the middle of the street or road. YES NO
3. In making a right turn from one street into another should the turn be made from the "lane" nearest the right edge of the street? YES NO
4. In approaching a "Stop" sign posted at a boulevard or through street a driver may just slow up instead of actually stopping his car. YES NO
5. In passing a car going in the same direction is it safer to pass to the right? YES NO
6. A car about to be passed by another going in the same direction has the right to hog the road and keep the following car from passing YES NO
7. A car following another at 35 miles an hour should leave more space between the cars than when the rate of speed is 20 miles per hour. YES NO
8. When two cars approach an intersection at right angles at approximately the same time, the driver of the car on the right shall have the right-of-way. YES NO
9. The driver of a vehicle having stopped at the entrance to a through street shall yield to other vehicles within the intersection or approaching it so closely as to constitute a hazard. YES NO
10. The driver of a car within an intersection intending to turn left has the right-of-way over any other vehicle approaching from the opposite direction that is within the intersection or so close as to constitute a hazard. YES NO
11. A car making a right turn on a "Go" signal has the right-of-way over the pedestrian crossing the street on the same "Go" signal. YES NO
12. When walking along highways pedestrians would be safer walking on left side of road against traffic than on right side of road with traffic. YES NO
13. When a street car begins to slow up drivers should "step on the gas" to hurry by. YES NO
14. When approaching a railroad crossing a driver should slow up to see whether a train is coming. YES NO
15. Should a car be decelerated quickly when turning a slippery curve? YES NO
16. Is the driver of the car behind the one in front of you usually careful? YES NO
17. Because of less traffic at night is it safe to drive faster than during the daytime? YES NO
18. Does a car have a tendency to swerve head-on into on-coming traffic when a left front tire blows out when driving? YES NO
19. When the rear of a car skids to the left, should the front wheels be turned to the left to straighten out? YES NO
20. When one is passing a car, is a short quick swing out as safe as a long gradual one. YES NO

Grade

A	B	C	D

Driving Test

Group A

Encircle the number in front of the statement which you think is the best choice.

1. If the car starts to skid on wet or icy pavement the best thing to do is to:
   1. Throw out the clutch and apply the brakes sharply.
   2. Apply the brakes carefully, leaving the clutch in.
   3. Shift into second gear and apply the brakes carefully.
2. When approaching an intersection without signals or signs and where the view is unobstructed, the best thing to do is to:
   1. Slow down to see if it is safe to proceed.
   2. Increase speed of car and hurry across.
   3. Come to a stop before proceeding.
3. It is better to put the best tires on:
   1. The rear wheels.
   2. The front wheels.
   3. The right front and rear.
4. In going down a hill the thing to do is to:
   1. Hope no emergency will arise.
   2. Throw out clutch and coast.
   3. Apply brakes carefully to keep car under control.
5. On a four-lane highway slow vehicles should keep:
   1. On one of the center lanes.
   2. On the extreme right lane.
   3. On part of two lanes.
6. When a car approaches from the rear to pass you should:
   1. Speed up and keep in front of car in rear.
   2. Pull over to right and allow car to pass.
   3. Pull over to left and allow car to pass.
7. Having injured someone in an accident you should first:
   1. Hurry away from accident.
   2. Call the police.
   3. Take victim to hospital or physician.
8. When pedestrian is crossing street, driver should:
   1. Proceed as though street were clear.
   2. Allow pedestrian to cross before proceeding.
   3. Attempt to bluff pedestrian back to curb.
9. In deciding to make a right turn it is better to:
   1. Get into lane on your right.
   2. Get into lane on your left.
   3. Pay no attention to your position.
10. Pedestrian in crossing street will find it safer:
    1. Crossing wherever he wants to in middle of block.
    2. Crossing at intersection against signal.
    3. Crossing at intersection on "go" signal.
11. In shifting from a lower gear to a higher, one of the following statements is correct:
    1. Push down the clutch pedal, stop feeding gas; let the clutch pedal up again.
    2. After pushing down the clutch pedal, feed gas, shift gears, then stop feeding gas as you let the clutch pedal up.
    3. Stop feeding gas, push down the clutch pedal, shift gears, let the clutch , pedal up, then feed the gas.
12. In going up a hill behind another car where there is any question of visibility it is safer to:
    1. Speed up and pass the car.
    2. Stay in line.
    3. Keep in middle of road as if to pass.

AUTOMECHANICS

No.__________ Name______________________

Class________ Total Score_____________
(No. Correct)

KNOWLEDGE TESTS

SIMILAR-DISSIMILAR TEST

Score_____________.
(No. Correct)

Mark each of the following as alike (A), or unlike (U).

Examples: Potatoes - Spuds (A)
Airplane - Train (U)

a. Tread - Width ( )
b. Electrolyte - Acid ( )
c. Camber - Bowlegged ( )
d. Carbon Monoxide - C O ( )
e. Fuel - Gasoline ( )
f. Oil - Lubricant ( )
g. Driving Gear - Ring Gear ( )
h. Spray Jet - Nozzle ( )
i. Engine Pan - Oil Pan ( )
j. Camshaft Gear - Timing Gear ( )
k. Starter - Starting Motor ( )
l. Light - Bulb ( )
m. Wheelbase - Length ( )
n. Piston Pin - Wrist Pin ( )
o. Magnetism - Magnets ( )
p. Stop Light - Tail Light ( )
q. Valve Lifter - Push Rod ( )
r. Toe-in - Pigeon-toed ( )
s. Chassis - Frame ( )
t. Sulphuric Acid - H_2SO_4 ( )
u. Amperes - Current ( )
v. Engine - Motor ( )
w. Lead Peroxide - PbO_2 ( )

NON-ESSENTIAL PARTS TEST

Score_____________
(No. Correct)

(Draw a line through the following parts that a car can run without.)

Air
Carburetor
Fenders
Heater
Oil
Speedometer
Transmission
Battery
Tools
Differential
Spark Plugs
Fuel
Mirror
Lights

Ammeter
Clutch
Frame
Horn
Radiator
Starter
Wheels
Air Cleaner
Water
Chassis
Springs
Flywheel
Paint
Hood

Brakes
Engine
Fuel Gauge
License
Shock Absorbers
Tires
Windshield Wiper
Acid
Windows
Bumpers
Steering Gear
Fan
Radio
Generator

MENTAL ARITHMETIC PROBLEMS TEST

Score__________
(No. Correct)

(Compute the following problems mentally and write the answers on the lines.)

a. Gasoline was bought for 16¢ a gallon and sold for 5¢ a quart.
How much profit was made on 10 gallons? __________
b. Oil was bought fro 40¢ a gallon and sold for 6¢ a pint.
How much profit was made on 3 gallons? __________
c. Two gallons of alcohol were bought at 5¢ a half-pint and three gallons
at two pints for 15¢. How much was paid for the five gallons? __________
d. First grade gasoline is 18¢ a gallon.
Average gasoline mileage cost is one cent per mile.
Third grade gasoline is 3¢ a quart.
How many more miles per gallon can a car be driven if first grade
gasoline is used instead of third grade? __________
e. What is the total profit of problems a, b, and c? __________

MENTAL VERBAL SKILL TEST

Score__________
(No. Correct)

(Arrange mentally the words of each line to form complete sentences, then draw a line through the one unnecessary word.)

Example: automobile ~~walks~~ runs the

a. fuel automobile explodes is gasoline
b. chassis the body supports head the
c. heads steel of cylinder made aluminum are
d. power the power during engines compression develop stroke
e. water more or gasoline car important is oil than
f. carbon is exhaust inhale gas which poison contains monoxide deadly

ANALOGIES TEST

Score__________
(No. Correct)

(Draw a line through the correct answer, one of the last four words of each line.)

Example: Thunder - lightning :: light - window - feather - ~~sun~~ - moon

a. Cugnot - steam cars :: Benz - benzol - Germany - gasoline cars - benzine
b. Frame - chassis :: skeleton - bones - corpse - eel - skull
c. Air - tires :: magnetism - electricity - magnets - shocks - invisible
d. Shock absorbers - springs :: cushions - seats - body - passengers - softness
e. Tread - wheelbase :: cylinder bore - piston stroke - drill - block - hole
f. Steering wheel - driver :: accelerator - tank - gas - carburetor - throttle
g. Air - engine :: oxygen - torch - lungs - fish - water
h. Intake stroke - one :: power stroke - horse - four - two - three
i. Piston - connecting rod :: flywheel - crankshaft - camshaft - clutch - valves
j. Valves - sixteen :: piston rings - eight - twelve - sixteen - twenty-four
k. Fuel - engine :: food - waste - chew - human - eat
l. Water - radiator :: oil - roads - engine - wells - hinges
m. Oil - friction :: water - battery - drink - overheating - radiator
n. Lead - battery :: aluminum - light - valves - flywheel - cylinder heads
o. Clutch - transmission :: wheels - tires - hubs - drums - axles
p. Silver - mirrors :: paint - gun - brush - body - wood
q. Fan belt - fan :: starter - turn - crank - battery - flywheel
r. Fuel gauge - fuel :: ammeter - volts - amperes - charge - discharge

Corrected by No.__________

No.________ Name________________

Class________ Total Score________ (No. Correct)

KNOWLEDGE TESTS

SIMILAR-DISSIMILAR TEST

Score________ (No. Correct)

Mark each of the following as alike (A), or unlike (U).

Examples: Potatoes - Spuds (A)
Airplane - Train (U)

a. Wheelbase - Length (   )
b. Grease - Lubricant (   )
c. Piston Pin - Wrist Pin (   )
d. Valve Lifter - Push Rod (   )
e. Toe-in - Pigeon-toed (   )
f. Amperes - Current (   )
g. Lead Peroxide - PbO_2 (   )
h. Engine - Motor (   )
i. Sulphuric Acid - H_2SO_4 (   )
j. Chassis - Frame (   )
k. Stop Light - Tail Light (   )
l. Magnetism - Magnets (   )
m. Light - Bulb (   )
n. Starter - Starting Motor (   )
o. Camshaft Gear - Timing Gear (   )
p. Engine Pan - Oil Pan (   )
q. Spray Jet - Nozzle (   )
r. Driving Gear - Ring Gear (   )
s. Fuel - Gasoline (   )
t. Carbon Monoxide - C O (   )
u. Camber - Bowlegged (   )
v. Electrolyte - Acid (   )
w. Tread - Width (   )

NON-ESSENTIAL PARTS TEST

Score________ (No. Correct)

(Draw a line through the following parts that a car can run without.)

Acid
Bumpers
Fan
Generator
Mirror
Spark Plugs
Tools
Horn
Radiator
Starter
Wheels
Fuel Gauge
Engine
Brakes

Air Cleaner
Chassis
Flywheel
Hood
Paint
Springs
Water
License
Shock Absorbers
Tires
Windshield Wiper
Frame
Clutch
Ammeter

Battery
Differential
Fuel
Lights
Radio
Steering Gear
Windows
Oil
Speedometer
Transmission
Heater
Fenders
Carburetor
Air

MENTAL ARITHMETIC PROBLEMS TEST

Score____________
(No. Correct)

(Compute the following problems mentally and write the answers on the lines.)

a. Gasoline was bought for 12¢ a gallon and sold for 4¢ a quart.
How much profit was made on six gallons? ____________
b. Oil was bought for 60¢ a gallon and sold for 10¢ a pint.
How much profit was made on two gallons? ____________
c. Three gallons of alcohol were bought at 10¢ a pint and two gallons at
two pints for 15¢. How much was paid for the five gallons? ____________
d. First grade engine oil is $1.20 a gallon.
Second grade engine oil is 10¢ a pint and should be changed every 2000 miles.
Third grade engine oil is 10¢ a quart.
How many more miles can a new car be driven between oil changes if
first grade oil is used instead of third grade? ____________
e. What is the total profit of problems a, b, and c? ____________

MENTAL VERBAL SKILL TEST

Score____________
(No. Correct)

(Arrange mentally the words of each line to form complete sentences, then draw a line through the one unnecessary word.)

Example: automobile ~~walks~~ runs the

a. gasoline automobile fuel is burns
b. body the frame the chassis supports
c. is steel the brass camshaft of made
d. exhaust develop the power engines stroke power during
e. water is oil than alcohol or gasoline important more
f. deadly poison which carbon exhaust breath contains is gas monoxide

ANALOGIES TEST

Score____________
(No. Correct)

(Draw a line through the correct answer, one of the last four words of each line.)

Example: Thunder - lightning :: light - window - feather - ~~sun~~ - moon

a. Air - engine :: oxygen - torch - lungs - fish - water
b. Valves - sixteen :: piston rings - eight - twelve - sixteen - twenty-four
c. Water - radiator :: oil - roads - engine - wells - hinges
d. Lead - battery :: aluminum - light - valves - flywheel - cylinder heads
e. Silver - morrors :: paint - gun - brush - body - wood
f. Cugnot - steam cars :: Benz - benzol - Germany - gasoline cars - benzine
g. Air - tires :: magnetism - electricity - magnets - shocks - invisible
h. Tread - wheelbase :: cylinder bore - piston stroke - drill - block - hole
i. Piston - connecting rod :: flywheel - crankshaft - camshaft - clutch - valves
j. Oil - friction :: water - battery - drink - overheating - radiator
k. Fuel gauge - fuel :: ammeter - volts - amperes - charge - discharge
l. Frame - chassis :: skeleton - bones - corpse - eel - skull
m. Steering wheel - driver :: accelerator - tank - gas - carburetor - throttle
n. Intake stroke - one :: power stroke - horse - four - two - three
o. Fuel - engine :: food - waste - chew - human - eat
p. Clutch - transmission :: wheels - tires - hubs - drums - axles
q. Fan belt - fan :: starter - turn - crank - battery - flywheel
r. Shock absorbers - springs :: cushions - seats - body - passengers - softness

Corrected by No.__________

HFTS

AUTOMECHANICS

TEST 1

Group A

No.________ Name ____________________

Corrected by No.__________

Class______________ Score ________ (No. Right)

Answer the following from memory.

1. (a) In which country (France, Germany, or United States) was the electric car invented? (b) The steam car? (c) The gasoline car?

   (a) (b) (c)

2. What are the three chief differences between the first Ford car and modern Ford car?

   (a) (b) (c)

3. Which major part of a car is more important, the body or the chassis? Why?

4. List two ways in which the Ford V-8 and the DeLuxe chassis are alike besides having similar parts.

5. List two differences between the DeLuxe and the Mercury chassis besides price, length, weight, and strength.

6. Why is the Ford body called a "safety" body? Give two answers.

7. Name the four most important pieces of DeLuxe body equipment.

8. How are the materials made into glass?

9. Is it possible to determine the age of Ford Safety Glass? Explain.

10. Give four advantages of plate glass over safety glass.

Grade

A	B	C	D

GROUP A

11. Name four parts of a car that make it ride smoothly.

12. What is the distance between the front and the rear wheel centers called?

13. (a) How would a broken drag link affect the steering of the right wheel?
    (b) The left wheel?
    (a)
    (b)

14. What does toe-in mean?

15. How do the stopping brakes differ from the parking brakes? Give four answers.

16. Which brakes will stop a Ford V-8 quicker, the hand-operated or the foot-operated? Why?

17. When are the brakes considered defective?

18. Which piston strokes occur when the piston is going down?

19. After which piston stroke does the spark occur?

20. Name the four principal moving non-rotating engine parts.

HFTS AUTOMECHANICS TEST 2

Group A No.________ Name________________________

Corrected by No.________ Class________ Score________________________ (No. Right)

Answer the following from memory.

1. Name the three moving parts of the fuel system.

2. Why is it dangerous to run an automobile engine in a closed garage?

3. How does carbon monoxide differ from city gas? Give two answers.

4. In what part of the engine is the water when it becomes heated?

5. What are the three causes of heat in an engine?

6. What are the two chief causes of a cracked engine?

7. Why is friction in an engine a disadvantage?

8. Name two engine parts that are lubricated by the oil pump.

9. What is the chief objection to using winter oil in summer?

10. What are the four chief purposes of the transmission?

Grade			
A	B	C	D

Group A

11. In which gear shift position has the car the most speed? Why?

12. How many gears are in a Ford V-8 transmission?

13. Why is the clutch located directly behind the engine?

14. Why is the transmission located directly behind the clutch?

15. What is the chief purpose of the rear axle housing?

16. Is it possible for one rear wheel to receive no power? Explain.

17. How does electricity differ from water? Give four answers.

18. How does a change in electrical voltage affect the amperes?

19. How are electricity and magnetism alike? Give four answers.

20. Give two advantages of a permanent magnet over an electromagnet.

H F T S

AUTOMECHANICS

TEST 3

Group A

No.________ Name ______________________________

Corrected by No.________

Class__________ Score ______________________________

(No. Right)

Answer the following from memory.

1. What are the two chief reasons for using a storage battery in an automobile?

2. Give four ways in which automobile storage batteries differ from each other.

3. Why is it dangerous to bring a battery near a flame?

4. What part of the electrical system would be affected the most if the generator failed? How affected?

5. When is the generator supplying the electrical system with electricity?

6. When the battery indicator pointer remains in the orange sector what does it indicate?

7. Give four ways of starting an engine.

8. How are the starter and generator alike? Give two answers.

9. Which terminal (post) of a Ford V-8 is grounded and why?

10. When and why must a car in Detroit have its lights on?

Grade

A	B	C	D

Group A

11. Name the four most important lights on a Ford V-8.

12. When should the headlight upper beams be used when driving?

13. What is the chief purpose of the ignition system?

14. Name the four chief parts of the ignition system?

15. How would the ignition system be affected if the switch was not in the "off" position when the engine was not running? Give two answers.

16. What is the bead of a tire?

17. What are the plies of a tire?

18. What is the tread of a tire?

19. Why are better drivers needed in the United States today?

20. What traffic ordinance is usually violated when fatal accidents occur?

Table of Decimal Equivalents from Sixteenths to Halves

16ths	$\frac{1}{16}$ = .06	$\frac{2}{16}$ = .12	$\frac{3}{16}$ = .18	$\frac{4}{16}$ = .25	$\frac{5}{16}$ = .31	$\frac{6}{16}$ = .37	$\frac{7}{16}$ = .43	$\frac{8}{16}$ = .50	$\frac{9}{16}$ = .56	$\frac{10}{16}$ = .62	$\frac{11}{16}$ = .68	$\frac{12}{16}$ = .75	$\frac{13}{16}$ = .81	$\frac{14}{16}$ = .87	$\frac{15}{16}$ = .93
15ths	$\frac{1}{15}$ = .06	$\frac{2}{15}$ = .13	$\frac{3}{15}$ = .20	$\frac{4}{15}$ = .26	$\frac{5}{15}$ = .33	$\frac{6}{15}$ = .39	$\frac{7}{15}$ = .46	$\frac{8}{15}$ = .53	$\frac{9}{15}$ = .60	$\frac{10}{15}$ = .66	$\frac{11}{15}$ = .73	$\frac{12}{15}$ = .80	$\frac{13}{15}$ = .86	$\frac{14}{15}$ = .93	
14ths	$\frac{1}{14}$ = .07	$\frac{2}{14}$ = .14	$\frac{3}{14}$ = .21	$\frac{4}{14}$ = .28	$\frac{5}{14}$ = .35	$\frac{6}{14}$ = .42	$\frac{7}{14}$ = .50	$\frac{8}{14}$ = .57	$\frac{9}{14}$ = .64	$\frac{10}{14}$ = .71	$\frac{11}{14}$ = .78	$\frac{12}{14}$ = .85	$\frac{13}{14}$ = .92		
13ths	$\frac{1}{13}$ = .07	$\frac{2}{13}$ = .15	$\frac{3}{13}$ = .23	$\frac{4}{13}$ = .30	$\frac{5}{13}$ = .38	$\frac{6}{13}$ = .46	$\frac{7}{13}$ = .53	$\frac{8}{13}$ = .61	$\frac{9}{13}$ = .69	$\frac{10}{13}$ = .76	$\frac{11}{13}$ = .84	$\frac{12}{13}$ = .92			
12ths	$\frac{1}{12}$ = .08	$\frac{2}{12}$ = .16	$\frac{3}{12}$ = .25	$\frac{4}{12}$ = .33	$\frac{5}{12}$ = .41	$\frac{6}{12}$ = .50	$\frac{7}{12}$ = .58	$\frac{8}{12}$ = .66	$\frac{9}{12}$ = .75	$\frac{10}{12}$ = .83	$\frac{11}{12}$ = .91				
11ths	$\frac{1}{11}$ = .09	$\frac{2}{11}$ = .18	$\frac{3}{11}$ = .27	$\frac{4}{11}$ = .36	$\frac{5}{11}$ = .45	$\frac{6}{11}$ = .54	$\frac{7}{11}$ = .63	$\frac{8}{11}$ = .72	$\frac{9}{11}$ = .81	$\frac{10}{11}$ = .90					
10ths	$\frac{1}{10}$ = .10	$\frac{2}{10}$ = .20	$\frac{3}{10}$ = .30	$\frac{4}{10}$ = .40	$\frac{5}{10}$ = .50	$\frac{6}{10}$ = .60	$\frac{7}{10}$ = .70	$\frac{8}{10}$ = .80	$\frac{9}{10}$ = .90						
9ths	$\frac{1}{9}$ = .11	$\frac{2}{9}$ = .22	$\frac{3}{9}$ = .33	$\frac{4}{9}$ = .44	$\frac{5}{9}$ = .55	$\frac{6}{9}$ = .66	$\frac{7}{9}$ = .77	$\frac{8}{9}$ = .88							
8ths	$\frac{1}{8}$ = .12	$\frac{2}{8}$ = .25	$\frac{3}{8}$ = .37	$\frac{4}{8}$ = .50	$\frac{5}{8}$ = .62	$\frac{6}{8}$ = .75	$\frac{7}{8}$ = .87								
7ths	$\frac{1}{7}$ = .14	$\frac{2}{7}$ = .28	$\frac{3}{7}$ = .42	$\frac{4}{7}$ = .57	$\frac{5}{7}$ = .71	$\frac{6}{7}$ = .85									
6ths	$\frac{1}{6}$ = .16	$\frac{2}{6}$ = .33	$\frac{3}{6}$ = .50	$\frac{4}{6}$ = .66	$\frac{5}{6}$ = .83										
5ths	$\frac{1}{5}$ = .20	$\frac{2}{5}$ = .40	$\frac{3}{5}$ = .60	$\frac{4}{5}$ = .80											
4ths	$\frac{1}{4}$ = .25	$\frac{2}{4}$ = .50	$\frac{3}{4}$ = .75												
3rds	$\frac{1}{3}$ = .33	$\frac{2}{3}$ = .66													
Halves	$\frac{1}{2}$ = .50														